GREENLIGHT:
Generating Renewable Energy Education Network - Leading Initiatives for Green & Harmonious Tomorrows

GREENLIGHT

Energy Literacy
Green Energy STEAM Workshops and Trainings

Teacher Guide and STEAM Lesson Plans

2023-2-TR01-KA220-SCH-000180691

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September, 2025

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About This Teacher Guide and STEAM Lesson Plans

This Teacher Guide and Lesson Plans document was developed within the scope of the GREENLIGHT: Generating Renewable Energy Education Network – Leading Initiatives for Green & Harmonious Tomorrows project. It was prepared as part of the Green Energy STEAM Workshops and Trainings work package to support teachers in promoting energy literacy, sustainability awareness, and green skills through hands-on, experiential, and student-centred learning activities.

The guide brings together five Green Energy STEAM lesson plans focusing on key aspects of energy education. These plans address the concepts of energy and energy sources, the relationship between energy and the environment, renewable energy practices in selected European countries, energy efficiency and energy saving, and the processes of renewable energy production.

Each lesson plan includes a clear context, learning aims, theoretical background, methodological guidance, classroom activities, assessment suggestions, and related annexes or worksheets. The activities are mainly designed for secondary school students aged 15–17 and aim to support active learning, collaboration, critical thinking, creativity, problem-solving, and environmental responsibility.

This guide is intended to help teachers integrate green energy concepts into their teaching practices and implement engaging classroom activities on renewable energy and sustainability. It also contributes to teacher training and capacity building by providing practical teaching materials, lesson plans, and resources that can be adapted to different classroom contexts.

The guide includes the following five Green Energy STEAM lesson plans:

- Lesson Plan 1: Exploring Energy and Energy Sources
- Lesson Plan 2: Energy and Environment
- Lesson Plan 3: Renewable Energy in Selected European Countries
- Lesson Plan 4: Energy Efficiency and Energy Saving
- Lesson Plan 5: Renewable Energy Sources and the Processes of Renewable Energy Production

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Exploring Energy and Energy Sources
Steam Plan 1

Teacher Guide and STEAM Lesson Plans

September, 2025

Project Partners

CONTEXT

The scope of this teacher's guide

This teacher's guide addresses the concept of energy source and distinguishes between renewable and non-renewable energy sources.

It presents two lesson plans to be used in conjunction with students' worksheets, developed to support them.

Each lesson plan was prepared for a 60-minute class and is supported by one or more students' worksheets.

The target Group is secondary school students aged 15–17 years old

The duration of the topic is 2 classes of 60 minutes each

Some general information, followed by the lesson plans (including information on when and how to use the students' worksheets) is provided for each lesson.

The subjects involved are Science, Technology, Computer Studies, and English.

The keywords that describe the lessons are: energy, renewable energy sources, non-renewable energy sources, sustainability, STEM, energy literacy.

Summary

This professional lesson plan enables students aged 15–17 to explore the concept of energy source, distinguish between renewable and non-renewable energy sources, and evaluate their environmental and social impacts. Through collaborative research, multimedia exploration, hands-on activities, and scenario-based discussions, students will develop critical thinking skills and energy literacy within a STEM framework.

Aims of the learning sequence

By the end of the teaching and learning sequence, students are expected to show **knowledge** of renewable and non-renewable energy sources, namely to:

- Define what energy sources are.
- Differentiate between renewable and non-renewable energy sources.
- Evaluate the environmental impact of various energy sources.
- Explain how energy sources work.

During the sequence, students will develop **21st-century** skills in the following areas:

- Creativity and innovation
- Critical thinking and problem-solving
- Communication and collaboration

- Information, media and technology literacy
- Initiative and self-direction

Methodological approach

The methodological approach relies on the following strategies:

- Collaborative learning
- Digital and visual learning
- Project-based learning
- STEM-integrated scenario work
- Media and technology skills development

The methodological approach acknowledges a **STEM orientation** by assuming:

- **Personalisation of learning:** Students choose an energy source to research according to their interests.
- **STEM topic integration:** Concepts of energy, environmental science and technological applications explored.
- **Formative assessment:** Continuous formative assessment through reflection and peer review.

Assessment guidelines

Assessment is continuously done based on formative practices to personalize learning and enhance the overall teaching and learning experience.

Formative assessment is embedded in the lesson activities. It should be done during class discussions, brainstorming activities, group work, hands-on experiments, project work, etc. Students' worksheets include a variety of tasks to be performed by the students that allow the teacher to observe progression on knowledge, reasoning, behavior, communication skills, social-relational skills, creativity, etc. They also allow students to express their understanding in different ways, providing evidence of how deeply they understand and can use the content. Formative assessment should consider issues like accuracy of scientific content, creativity in presentation, collaboration and teamwork, critical thinking and clarity of reasoning, communication and argumentation, and engagement with the tasks.

To strengthen active participation, both self-assessment and peer assessment play a central role. Therefore, students are asked to reflect on their learning and contribution to the group, to evaluate their group's collaboration, and the performance of the different groups, etc. In addition to teachers' questions, worksheets include questions with this aim.

Together, these assessment practices provide a holistic view of each student's progress, enabling the teacher to adapt instruction to individual needs while helping students become reflective, self-directed participants in their own education.

Theoretical background

We obtain the energy needed to power our daily lives, industries, and technological systems from energy sources. They can be broadly classified into two categories: renewable and non-renewable energy sources. Renewable energy sources, such as sun, wind, water, geothermal heat, and biomass, are replenished naturally and have lower environmental impacts. Non-renewable sources, such as coal, oil, natural gas, and uranium, are finite, and their use contributes to environmental degradation.

Understanding the advantages and limitations of each energy source is essential in creating sustainable energy strategies. For example, while fossil fuels provide high energy output and are currently integrated into global infrastructure, their extraction and combustion contribute significantly to greenhouse gas emissions. Conversely, renewable sources offer long-term sustainability but may be limited by geographic, technological, or economic constraints.

You can get more information on energy here:
https://www.projectgreenlighteu.com/Home/ePlatform?section=definition

You can learn about some myths on energy here
https://www.projectgreenlighteu.com/Home/ePlatform?section=myths

You can get more information on energy sources here:
https://www.projectgreenlighteu.com/Home/ePlatform?section=futurePers

Additional information available at: https://www.projectgreenlighteu.com/Home/Resources

LESSON PLANS ON ENERGY AND ENERGY SOURCES (ESx)

Time: 120 minutes (2 x 60 minutes)

Teacher's materials: 2 lesson plans, including videos

Students' materials: 6 worksheets

Lesson Plan ES1 (60 minutes)

The first lesson introduces students to the concept of energy sources, stimulates curiosity through multimedia, and engages them in collaborative classification activities.

1. Kick-off (15 min): Show a short, engaging video introducing energy sources available from: https://www.youtube.com/watch?v=UrJUkRr8YQo

   Ask students what comes to their mind when they think of energy.

   At this stage, energy is difficult to define precisely. Emphasize examples and experiences rather than formal definitions. Allow students to share anything that comes to mind - objects, movements or natural phenomena - then guide them toward the idea that energy is what makes things happen or change.

2. Introduction to energy sources (15 min): Using a collaborative Canva presentation (https://tinyurl.com/muk4p53x), give clear definitions of *energy*, highlighting the difference between **forms of energy** (kinetic and potential), **types of energy** (e.g., thermal, electrical,

sound energy, etc.) and **energy sources** (where energy comes from, such as the sun, wind, water, or fossil fuels). Then, differentiate renewable from non-renewable energy sources and name the type of energy each one provides.

3. Application Activity (15 min): Hand out Worksheet ES1. Ask small groups of students (3 to 5 students) to answer the questions about the different renewable and non-renewable sources of energy represented in the images, the key advantages, disadvantages, and interesting facts about each energy type.
4. Reflection (10 min): Ask groups to share their answers with the others. Summarise and correct any misconceptions that may emerge.
5. Homework (5 min): Each student selects one energy source as required by Worksheet ES2, to research and answer the questions for the next class.

Alternative homework: Write the following questions on the board and ask students to copy them into their diary notebook or a piece of paper, to answer at home:

- What renewable energy sources does your home use?

- How could you include more renewable energy in your home?

Lesson Plan ES2 (60 minutes)

The second lesson focuses on applying knowledge through project-based learning and scenario problem-solving.

1. Homework Review (10 min): Students share the findings from their research on their chosen energy source. As each student/group presents, note key points on the board or a shared digital space. Facilitate a short discussion by comparing similarities, differences, and surprising findings between the renewable energy sources. Summarize the main takeaways.
2. Scenario discussion (10 min): Introduce the following scenario to the students:

A city near your place wants to reach 60% renewable energy by 2035. As an expert in energy, you are invited to help the Municipality decide which energy source or sources they should use. The task of your group is to make a proposal to be presented to the municipality. You should decide which energy sources the city should use and explain your choices.

Make sure students understand the task.

3. Problem-solving (10 minutes): Handout Worksheet ES3, which includes the scenario. Ask small groups of students to solve the problem, that is, to make a proposal to help the Municipality reach the target.

   They can use information on renewable energy sources they researched in their own region, combine their findings, evaluate which local sources are feasible, and propose an energy mix with justifications.

   Afterward, students should be asked to share their solutions with the class briefly. Other groups should peer assess their presentation using Worksheet ES4.
4. Brochure Creation (10 min): Ask the same groups of students to create a brochure (on a piece of paper) that persuades people in their community to conserve energy. Hand out Worksheet ES5, where they can find instructions on how to create a good brochure.

ANNEXES

Annex 1: Glossary

- **Energy**: The ability to do work or cause change.
- **Types of energy**: have to do with the different ways energy manifests itself: thermal, light, mechanical and chemical energy.
- **Forms of energy:** are broad classifications of energy which encompass kinetic energy, the energy of motion, and potential energy, due to position or state. Examples include the energy of a moving car (kinetic) and the energy of water stored in a high dam (potential).
- **Renewable Energy**: Energy derived from natural sources that are constantly replenished, such as sunlight, wind, flowing water and biomass.
- **Non-renewable Energy**: Energy obtained from sources that cannot be replenished on a human time scale, such as fossil fuels.
- **Fossil Fuels**: Energy sources formed from the remains of ancient plants and animals, including coal, oil and natural gas.
- **Solar Energy**: Energy harnessed from the sun's rays, often captured using solar panels or solar thermal systems.
- **Wind Energy**: Energy generated by converting the kinetic energy of wind into electrical power using turbines.
- **Hydroelectric energy**: Energy produced by using the flow of water to generate electricity, usually through dams or small-scale river turbines.
- **Biomass Energy**: Energy produced from organic materials such as wood, agricultural residues, or animal waste, through burning or composting processes.
- **Sustainability**: Using resources in a way that meets current needs without compromising the ability of future generations to meet theirs.
- **Energy Efficiency**: Using less energy to perform the same task, reducing waste and environmental impact.
- **Energy Saving:** Reducing overall energy consumption by changing habits, using energy-efficient technologies, or improving existing processes.

5. Presentation & Peer Review (10 min): Each group presents its brochure briefly. Peers provide feedback using the 'Fist-to-Five' technique.
6. Reflection (5 minutes): Students complete Worksheet ES6, to reflect on how they feel about the Exploration of Energy and Energy Sources.
7. Self-assessment (5 minutes): Invite students to play the games available at https://www.projectgreenlighteu.com/Home/ePlatform?section=energyGames

Assessment

Assessment across both lessons is **continuous** and combines **teacher evaluation** with **student self- and peer-assessment**.

Suggested **Teacher Assessment** Strategies:

- Observe and evaluate students' participation, collaboration and comments during group work, discussions and presentations.
- Assess final outputs—**scenario solutions and brochures**—for content accuracy, creativity, clarity, and teamwork.

Suggested **Student's Assessment** Strategies:

- Use **one simple checklist** (for both self- and peer-assessment) after group activities to reflect on understanding, contribution, and constructive feedback.
- Apply the **Fist-to-Five** technique as a quick formative check during presentations to gauge understanding and engagement.

This streamlined approach ensures meaningful feedback without overloading class time, while encouraging reflection, collaboration, and ownership of learning.

Interdisciplinary Connections of the Topic

The lessons have connections with several subjects, as follows:

- Science: Classification and analysis of energy sources
- Geography: Influence of geographic factors on energy production.
- Economics: Cost analysis and sustainability considerations.
- Technology/Art: Use of digital tools for visual communication.

Additional Notes for Teacher

Ensure access to digital devices and reliable internet.

Encourage creativity and use of free online tools like Canva (https://www.canva.com/design-school/).

Maintain a balance between teacher-led instruction and student-centered exploration.

Adapt timing if groups need additional time for discussions or brochure creation (https://www.youtube.com/watch?v=ukLIYgRloWU)

ADDITIONAL SUGGESTIONS

PLEASE MAKE THESE APPLICATIONS BEFORE THE FINAL EVALUATION PHASE.

Video / Activity	Planning Part	Integration Format	Outcomes
YouTube: "What is Energy?"	**Lesson ES1 Kick-off (10 min)**	Introducing the concept of energy. After the video, a discussion on "What is energy?"	Differentiating different forms of energy, activating students' prior knowledge.
Solar Oven STEM activity (ScienceBuddies) + YouTube + YouTube Demonstration	**Lesson ES2 – Create a brochure or additional practice time**	Students can build a solar oven as their own "renewable energy application." It can be included in an observation report or brochure as an example of "renewable energy at home."	Discovering the functioning of solar energy, the engineering-design process.

Annex 2: Checklist for Lesson Activities

- **Definition & Understanding:** Has the student understood and can clearly explain what this specific type of energy is (Solar/Wind/Hydroelectric/Biomass energy)?
- **Classification:** Was the correct categorization made (renewable/non-renewable) and were key characteristics of each category identified?
- **Key Concepts:** Are essential details included (method of production, technologies, current levels of use, prospects)?
- **Pros & Cons:** Are at least two advantages and two disadvantages identified for each energy source use?
- **Environmental Impacts:** Are the positive/negative impacts on the environment accurately described?
- **Real-world Examples:** Are there concrete examples from students' countries/Europe/the world showing practical application?
  - Solar: e.g., Portugal – Solar farm of Amareleja ; Greece – Chronus Kozani Solar PV Park, **Turkey – Karapınar Solar Power Plant**.
  - Wind: e.g., Wind farm in Mani offshore wind turbines (general example: North Sea); Turkey – Balıkesir Bandırma Wind Farm.
  - Hydropower: e.g., Kremasta Hydroelectric Plant small "run-of-river" facilities.
  - Biomass: e.g., Biomass units in Western Macedonia use of agricultural residues, Turkey – Konya Biomass Power Plant, using agricultural waste.
- **Collaboration:** Was there effective teamwork (role distribution, time management, conflict resolution)?
- **Creativity:** Was creativity incorporated (poster/infographic, role-play, original solutions to scenarios)?
- **Critical Thinking:** Were positions supported with evidence? Were options compared and justified?
- **Use of Digital Tools:** Were Canva/Genially/Kahoot/Google Forms effectively used for research, organization, and presentation?
- **Presentation Skills:** Were the presentations clear, well-structured, and adapted to the audience?
- **Reflection:** Was self- and peer-assessment carried out (e.g., Fist-to-Five, short reflective responses) with clear next steps for improvement?
- **Visual & Communication Clarity:** In visual work, were appropriate images/icons/layouts used to ensure readability and an engaging outcome?

Annex 3 – Energy Source Cards

Annex to Worksheet WES1

Water	Coal	Sun
Your answer:	Your answer:	Your answer:
v		
Oil	Wind	Biomass
Your answer:	Your answer:	Your answer:
Natural Gas	Sea waves	Uranium
Your answer:	Your answer:	Your answer:

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Energy and Environment
Steam Plan 2

Teacher Guide and STEAM Lesson Plans

September, 2025

Project Partners

CONTEXT

The scope of this teacher's guide

This teacher's guide addresses the relationship between energy and the environment and emphasizes the risks of non-renewable energy sources.

It presents two lesson plans to be used in conjunction with students' worksheets, developed to support them.

Each lesson plan was prepared for a 60-minute class and is supported by one worksheet.

The target Group is secondary school students aged 15–17 years old.

The duration of the topic is 2 classes of 60 minutes each.

Some general information, followed by the lesson plans (including information on when and how to use the students' worksheets) is provided for each lesson.

The subjects involved are Science, Technology, Geography, Economics, and English.

The keywords that describe the lessons are: renewable energy sources, non-renewable energy sources, environmental impact, eco-anxiety, sustainability, STEM, energy literacy.

Summary

This lesson plan enables students aged 15–17 to compare the **environmental advantages and disadvantages** of renewable and non-renewable energy sources, understand **Europe's evolving energy use** and discuss **eco-anxiety** constructively. Through collaborative research, multimedia exploration, debates and reflective activities, students will develop **critical thinking, media literacy and emotional awareness within a STEM framework.**

Aims of the learning sequence

By the end of the teaching and learning sequence, students are expected to show **knowledge** of the relationship between energy and the environment, namely to:

- Identify renewable and non-renewable energy sources.
- Evaluate the environmental impacts of different energy types.
- Describe the effects of eco-anxiety.
- Identify constructive coping strategies for eco-anxiety.
- Propose balanced energy mixes considering environmental, social, and economic factors.

During the sequence, students will develop **21st-century** skills in the following areas:

- Creativity and innovation
- Critical thinking and problem-solving

- Communication and collaboration
- Information, media, and technology literacy
- Initiative and self-direction

Methodological approach

The methodological approach relies on the following **strategies**:

- Collaborative learning
- Digital and visual learning
- Project-based learning
- STEM-integrated scenario work
- Media and technology skills development

The methodological approach acknowledges a **STEM orientation** by assuming:

- **Personalisation of learning:** Reflecting on eco-anxiety and proposing actions.
- **STEM topic integration:** Links between environmental science, energy technology and societal issues.
- **Formative assessment:** Continuous formative assessment through reflection and peer review.

Assessment guidelines

Assessment is continuously done based on formative practices to personalize learning and enhance the overall teaching and learning experience.

Formative assessment is embedded in the lesson activities. It should be done during class discussions, brainstorming activities, group work, project work, etc. Students' worksheets include a variety of tasks to be performed by the students that allow the teacher to observe progression on knowledge, reasoning, behavior, communication skills, social-relational skills, creativity, etc. They also allow students to express their understanding in different ways, providing evidence of how deeply they understand and can use the content. Formative assessment should consider issues like accuracy of scientific content, creativity in presentation, collaboration and teamwork, critical thinking and clarity of reasoning, communication and argumentation, and engagement with the tasks.

To strengthen active participation, both self-assessment and peer assessment play a central role. Therefore, students are asked to reflect on their learning and contribution to the group, to evaluate their group's collaboration, and the performance of the different groups, etc. In addition to teachers' questions, worksheets include questions with this aim.

Together, these assessment practices provide a holistic view of each student's progress, enabling the teacher to adapt instruction to individual needs while helping students become reflective, self-directed participants in their own education.

Theoretical background

Europe has doubled its renewable energy share since 2005, reaching approximately 25% of gross final energy consumption in 2023, with a goal of **42.5% by 2030**. While **coal** use is declining, **natural gas** and **nuclear** remain significant. Renewable energy reduces greenhouse gases, but may affect wildlife (e.g., wind turbines and birds) and require new infrastructure. Fossil fuels are **finite**, polluting, and linked to geopolitical tensions. **Eco-anxiety** - feelings of worry about environmental crises - is increasingly reported among European youth. Addressing these feelings through education and action fosters agency rather than despair.

More scientific and technical information on these issues can be found in an e-book available at: https://www.projectgreenlighteu.com/Home/ePlatform?section=relationship

https://www.projectgreenlighteu.com/Home/ePlatform?section=futurePers

https://www.projectgreenlighteu.com/Home/ePlatform?section=nonRenewable

https://www.projectgreenlighteu.com/Home/ePlatform?section=renewGlobal

Additional information available at: https://www.projectgreenlighteu.com/Home/Resources

LESSON PLANS ON ENERGY AND ENVIRONMENT (EEX)

Time: 120 minutes (2 x 60 minutes)

Teacher's materials: 2 lesson plans, including videos

Students' materials: 2 worksheets

Lesson Plan EE1 (60 minutes)

The first lesson introduces students to the advantages, disadvantages, and environmental risks of nonrenewable energy, stimulates curiosity through multimedia, and engages them in collaborative research activities.

1. Kick-off (10 min): Show two images: one of a coal power plant and another of a wind farm. See: https://www.canva.com/design/DAGziq7HYsY/7cVhY8zeG0ZsAGh9bXT3cg/edit?utm_content=DAGziq7HYsY&utm_campaign=designshare&utm_medium=link2&utm_source=sharebutton

   Promote brainstorming by asking students which one (coal power plants or wind farms) can be seen more today than 20 years ago, and why.

   Indicative Answer

   "You see wind farms more often today than 20 years ago. This is because many countries are shifting toward renewable energy to reduce greenhouse gas emissions and their effect on climate change. Advances in technology have made wind turbines more efficient and affordable, and governments often provide incentives for clean energy. At the same time, some coal power plants have closed or reduced output because coal is a major source of pollution and carbon dioxide."

2. Introduction to changes in energy use (10 min): Show a short video clip on changes in renewable and non-renewable energy use. You can use the video available from: https://www.youtube.com/watch?v=HA8-zysCxE4

   Ask students why they think about key data, like: the percentage of renewable energy in 2023 was 25%; coal use is declining, the impact/challenge of renewable energy for wildlife.

3. Fossil Fuel Detective activity (25 min): Hand out Worksheet EE1 and ask small groups of students (3 to 5 students) to conduct the Fuel Detective tasks, which require them to search for information, analyse data, and conclude about the vantages, disadvantages, and risks of using coal, oil, and natural gas.

4. Reflection (10 min): Ask groups to share their conclusions with the others. Summarise and correct any misconceptions that may emerge.

Indicative answers for question 2 of Worksheet EE1

Fossil Fuel	Where It Comes From	Advantages	Disadvantages	Environmental Risks
Coal	Mined from underground seams or surface mines; formed from ancient plant matter.	Reliable and abundant energy supply.	Produces high CO_2 emissions (climate change). Air pollution (soot, sulfur dioxide).	Acid rain, habitat destruction.
Oil	Extracted from underground reservoirs or seabeds; refined into fuels.	High energy density, easy to transport.	Non-renewable, finite resource. Price volatility and geopolitical tensions.	Oil spills damaging marine ecosystems.
Natural Gas	Found in underground rock formations, often with oil deposits; obtained through drilling or fracking.	Burns cleaner than coal or oil (lower CO_2).	Still emits greenhouse gases. Methane leaks are potent contributors to warming.	Fracking can contaminate groundwater.

Indicative answers for questions 3 and 4 of Worksheet EE1

Societies continue to use fossil fuels despite their environmental problems because they remain a reliable and energy-dense source of power, capable of meeting the constant demands of industries, homes, and transportation. Much of the existing energy infrastructure—such as power plants, pipelines, and refineries—is built around fossil fuels, making the transition to renewables expensive and complex. Economically, many regions rely on fossil fuels for jobs, government revenue, and trade, while in the short term, fossil fuels can still be cheaper and more accessible than some renewable options. Finally, shifting entirely to renewables requires significant investment in new technologies, storage solutions, and updated power grids, which takes time and careful planning."

5. Self-assessment (5 minutes): Invite students to play the games available at https://www.projectgreenlighteu.com/Home/ePlatform?section=NREGames

Lesson Plan ES2 (60 minutes)

The second lesson addresses the concept of energy mix through problem-based learning.

1. Kick off (10 min): Display a quote: "I worry about climate change every day". Ask students how they feel when they think about environmental issues.

   Let students share their feelings. Normalize feelings to prevent fear and anxiety.

2. Introduction of "eco-anxiety" (5 min): Present eco-anxiety as a common emotional response to environmental threats, a fear of suffering an environmental cataclysm. Tell students that possessing knowledge of sources of energy and their relationship with the environment promotes sustainable behaviors and reduces environmental threats and disasters.

   Alternatively, if you have time, you can use the video on eco-anxiety available from https://youtu.be/JMpkfq7o06A?si=PiTd6Qul5r022VNA-

3. Problem-solving (20 min): Handout Worksheet EE2, which asks students to play the role of European Energy Planners 2030 and suggest an Energy Mix, considering data and constraints provided.

   Ask small groups of students to solve the problem, that is, to create a balanced energy mix that meets environmental, economic, and social goals.

Sample Solution

Example Balanced 2030 Mix (Out of 100%):

- Wind: **30%**
- Solar: **20%**
- Hydro: **10%**
- Nuclear: **15%**
- Natural Gas: **15%** (as backup/transition fuel)
- Biomass/Other Renewables: **10%**

Reasoning:

- Keeps CO_2 low (only 15% fossil).
- Maintains reliability with nuclear and gas as backups.
- Uses a variety of renewables to reduce dependence on a single source.
- Considers cost and public acceptance (avoids 100% nuclear or fossil).

How Students Can Use the Data

- Calculate **% renewable vs. fossil** in their proposed mix.
- Estimate **average CO_2 emissions** for their energy mix using a weighted average.
- Consider **average cost per MWh** using a weighted calculation.
- Justify choices based on reliability and public acceptance.

4. Presentation & Peer Review (10 min): Each group presents their proposal briefly. Peers provide feedback using the 'Fist-to-Five' technique. Teacher's assessment focus:
   - Did the group use data trends?
   - Did they explain trade-offs (e.g., cost vs. emissions)?
   - Was the mix feasible given 2030 targets?

5. Reflection (10 min): Ask students to write or discuss one personal or community action to address climate change or eco-anxiety (e.g., energy-saving habits, advocacy, joining environmental clubs).

   Alternatively, show the mix of energy in your school area and discuss it with students to find out how far from the ideal one it is.

6. Self-assessment (5 minutes): Invite students to play the games available at https://www.projectgreenlighteu.com/Home/ePlatform?section=renewGames

Assessment

Assessment across both lessons is **continuous** and combines **teacher evaluation** with **student self- and peer-assessment**.

Suggested **Teacher Assessment** Strategies:

- Observe and evaluate students' participation, collaboration and comments during group work, discussions and presentations.
- Assess final outputs—Fossil Fuel Detective data collected and European Energy Planners 2030 energy mix and presentation—for content accuracy, creativity, clarity, and teamwork.

Suggested **Student's Assessment** Strategies:

- Use **one simple checklist** (for both self- and peer-assessment) after group activities to reflect on understanding, contribution, and constructive feedback.
- Apply the **Fist-to-Five** technique as a quick formative check during presentations to gauge understanding and engagement.

This streamlined approach ensures meaningful feedback without overloading class time, while encouraging reflection, collaboration, and ownership of learning.

Interdisciplinary Connections of the Topic

The lessons have connections with several subjects, as follows:

- Science: Classification and analysis of energy sources
- Geography: Geographic origin of energy sources and use.
- Economics: Cost analysis and sustainability considerations.
- Technology/Art: Use of digital tools for visual communication.

– English: Information bibliographic search

Additional Notes for Teacher

Ensure access to digital devices and reliable internet.

Encourage information search in reliable sources.

Ensure academic integrity by promoting authorship and explicit references.

ADDITIONAL SUGGESTIONS

PLEASE MAKE THESE APPLICATIONS BEFORE THE FINAL EVALUATION PHASE.

Video/Activity	Planning Part	Integration Format	Outcomes
How to Build a Solar Oven YouTube+1 Solar Oven STEM activity (ScienceBuddies)	**Lesson EE1 – After the fossil fuel detective activity (20 min)**	Building a pizza-box solar oven as a group in class, following Science Buddies instructions.	Experiencing the conversion of solar energy into heat; measuring data (temperature) and interpreting the results.
Build a Solar-Powered Model Car (Junior Solar Sprint Guide) YouTube+1	**Lesson EE2 – Problem Solving/ Capstone Project (20–30 min + competition)**	Prototyping a small-panel solar vehicle; organizing a race or performance test.	Hands-on learning of electrical→mechanical conversion of solar energy; design-test cycle.

How to Make a Mini Wind Turbine / Miniature Windmill (DIY) YouTube+1	**Lesson EE1 – Reflection / Bonus Project**	Making a mini turbine with cardboard/wood+simple motor; wind speed etc. production relationship is measured.	Examining the working principle and efficiency effects of wind energy.
Mini Waterwheel Experiment — Discover Water Power (STEM Activity) YouTube+1	**EE1 or EE2 – Extension activity/ homework**	Making a mini water wheel and observing the movement of the wheel with water flow (flow-power relationship).	Recognize the potential kinetic energy conversion that occurs with water flow and understand the role of water power in mechanical energy production.
Produce Small Batch Biogas / DIY Biogas YouTube+1	**EE2 – Before the Energy Mix discussion (short presentation)**	Model showing how biomass/biogas is produced; demonstration with attention to safety/ odor.	Understanding the energy contribution and sustainability of biomass.

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Renewable Energy in Selected European Countries Steam Plan 3

Teacher Guide and STEAM Lesson Plans

September, 2025

Project Partners

CONTEXT

The scope of this teacher's guide

This teacher's guide addresses how energy use has evolved in Europe, focusing on Greece, Turkey, Portugal, and North Macedonia.

It presents one lesson plan to be used in conjunction with a students' worksheet, developed to support a 60-minute class.

The target Group is secondary school students aged 15–17 years old.

Some general information, followed by the lesson plan, is provided for the lesson.

The subjects involved are Science, Technology, Geography, and English.

The keywords that describe the lessons are: renewable energy use, sustainability, STEM, Europe energy use.

Summary

This interactive STEM lesson engages students in exploring how energy use has evolved in Europe, focusing on Greece, Turkey, Portugal, and North Macedonia. Students analyze infographics, play a movement-based quiz game, predict future energy scenarios, and propose creative energy policies.

Aims of the lesson

By the end of the teaching and learning sequence, students are expected to show **knowledge** of the relationship between energy and the environment, namely to:

- Interpret simple energy trend charts for selected European countries.
- Compare renewable energy growth rates between countries.
- Develop creative strategies for future energy use.

During the sequence, students will develop **21st-century** skills in the following areas:

- Creativity and innovation
- Critical thinking and problem-solving
- Communication and collaboration
- Information, media, and technology literacy
- STEM Literacy

Methodological approach

The methodological approach relies on the following **strategies**:

- Collaborative learning (small group work, role-play)
- Gamification (interactive quiz with movement)
- Visual learning (maps, infographics, charts)
- Project-based exploration (energy councils)
- Formative assessment (observation, sticky notes)

The methodological approach acknowledges a **STEM orientation** by assuming:

- **Personalisation of learning:** reflection on energy choices.
- **STEM topic integration:** Links between renewable energy, geographical conditions, energy technology, and societal issues.
- **Formative assessment:** Continuous formative assessment through reflection and peer review.

Assessment guidelines

Assessment is continuously done based on formative practices to personalize learning and enhance the overall teaching and learning experience.

Formative assessment is embedded in the lesson activities. It should be done during class discussions, group work, role-playing, etc. Students' worksheets include a variety of tasks to be performed by the students that allow the teacher to observe progression on knowledge, reasoning, behavior, communication skills, social-relational skills, creativity, etc. They also allow students to express their understanding in different ways, providing evidence of how deeply they understand and can use the content. Formative assessment should consider issues like accuracy of scientific content, creativity in presentation, collaboration and teamwork, critical thinking and clarity of reasoning, communication and argumentation, and engagement with the tasks.

To strengthen active participation, both self-assessment and peer assessment play a central role. Therefore, students are asked to reflect on their learning and contribution to the group, to evaluate their group's collaboration, and the performance of the different groups, etc. In addition to teachers' questions, worksheets include questions with this aim.

Together, these assessment practices provide a holistic view of each student's progress, enabling the teacher to adapt instruction to individual needs while helping students become reflective, self-directed participants in their own education.

Theoretical background

Europe has doubled its renewable energy share since 2005, reaching approximately 25% of gross final energy consumption in 2023, with a goal of **42.5% by 2030**. European countries are using accessible renewable energy sources to fulfil this target at their own pace.

More scientific and technical information on these issues can be found at:

https://www.projectgreenlighteu.com/Home/ePlatform?section=Renewable

Additional information available at: https://www.projectgreenlighteu.com/Home/Resources

LESSON PLANS ON RENEWABLE ENERGY IN SELECTED EUROPEAN COUNTRIES (REEC)

Time: 60 minutes

Teacher's materials: 1 lesson plan

Students' materials: 2 worksheets

Lesson Plan REEC1 (60 minutes)

This lesson introduces students to how energy use has evolved in Europe, focusing on Greece, Turkey, Portugal, and North Macedonia, and stimulates students' curiosity through multimedia, and gamification and engages them in collaborative activities.

1. Kick-off (10 min): Ask students: "*Imagine you are the energy minister of your country. How would you power your city? With coal, wind, solar, or something else? Why?*"

   Quick show of hands: "Who would pick renewable energy?"

   Introduce the countries (Greece, Turkey, Portugal, North Macedonia) and show a map. Discuss the use of different types of energy sources and which prevail in each country:

   Possible answers (not a single one)

   Possible choices from students:
   - Coal → Cheaper in some areas, but high emissions of greenhouse gas.
   - Wind → Clean, abundant in coastal areas (Portugal, Greece).
   - Sun → Sunny climates (Greece, Turkey) make this ideal.
   - Hydro → Works well in mountainous regions with rivers (Portugal, North Macedonia).

   Key point to emphasize: Different geography and policies influence choices.

2. Mini "Energy Quiz Game" (10 min): Ask students to solve the questions in worksheet REEC1. Students have to choose one of the four possible answers for each question. They should answer by moving to the corners of the room labeled A, B, C, D (like the possible answers). Keep it fast, interactive, and playful. In the end, correct students' answers.

   Correct answers

   1. B) Portugal ☑ (Correct: Portugal's renewables are ~63%, with wind a major contributor)
   2. B) Turkey ☑ (Turkey uses significant coal for electricity)
   3. C) 45% ☑ (Approx. 45.3%)
   4. D) North Macedonia ☑
   5. B) Solar ☑

3. Data Detective Activity (20 min): Ask small groups of 3 to 5 students to carry out the tasks in the Worksheet REEC2.

   Afterwards, promote a class discussion of the groups' answers.

Indicative answers

Fastest-growing renewable energy:
- Greece: Wind and solar energies (especially solar installations).
- Portugal: Wind energy (plus solar expansion).
- Turkey: Solar and wind energies.
- North Macedonia: Small-scale hydro, and some solar energy.

Country lagging behind:
- North Macedonia (lowest renewable share).

Sample energy predictions for 2030:
- "Portugal could reach 70% renewables by 2030 if trends continue."
- "Turkey might balance 50–55% renewables but will still use natural gas."
- "Greece could phase out most coal and rely on solar + wind."
- "North Macedonia may double its renewable share if investment increases."

4. Energy Council activity (10 min): Introduce the following scenario to students and ask them to answer the questions in small groups (3 to 5) and prepare a short presentation for their class.

Scenario

Your group is invited to pick up one Partner country (Greece, Turkey, Portugal, North Macedonia) and to become its "energy council.".

For the chosen country, the group should decide:
- Which energy source to invest in next
- One fun policy to encourage renewable energy (e.g., free solar panels for houses, wind-energy powered schools).

Ask the groups to present their country's "energy plan", in 1 minute, to the class, explaining why their choice is best.

Possible energy plans and slogans

Country	Energy Choice	Fun Policy Example	Slogan Example
Portugal	Expand wind farms	Tax breaks for communities hosting turbines	"Portugal: Wind to Win!"
Greece	Invest in solar power	Free rooftop solar panels for schools	"Greek Sun, Bright Future!"
Turkey	Combine solar + wind	Subsidies for local solar businesses	"Turn Up the Sun, Power the Future!"
North Macedonia	Small hydro + solar	EU partnership grants for renewable infrastructure	"North Macedonia: Powering Progress!"

5. Wrap-up discussion (5 min): Ask students:

- about the key ideas they learned during the class, and
- if they were a member of the government, what would be their first step toward renewable energy?"

Guidelines for the discussion

Key points to highlight:
- Renewable energy is increasing everywhere, but progress differs.
- Geography matters: Sunny climates → solar; windy coasts → wind.
- Economic and political factors (e.g., investment, EU targets) shape progress.

Encourage reflections like:
"Invest in rooftop solar panels."
"Subsidize wind farms in coastal areas."
"Upgrade energy grids for renewables."

6. Self-assessment (5 minutes): Invite students to play the games available at https://www.projectgreenlighteu.com/Home/ePlatform?section=renewGames

Assessment

Assessment across the lesson is **continuous** and combines **teacher evaluation** with **student self- and peer-assessment**.

Suggested **Teacher Assessment** Strategies:

- Participation in quizzes and activities
- Ability to interpret simple data charts
- Creativity in scenario role-play

Suggested **Student's Assessment** Strategies:

- Use **one simple checklist** (for both self- and peer-assessment) after group activities to reflect on understanding, contribution, and constructive feedback.
- Apply the **Fist-to-Five** technique as a quick formative check during presentations to gauge understanding and engagement.

This streamlined approach ensures meaningful feedback without overloading class time, while encouraging reflection, collaboration, and ownership of learning.

Interdisciplinary Connections of the Topic

The lessons have connections with several subjects, as follows:

- Science: Classification and analysis of energy sources
- Geography: Geographic availability of energy sources and use
- Technology/Art: Use of digital tools for visual communication
- English: analysis of infographics

ADDITIONAL SUGGESTIONS

PLEASE MAKE THESE APPLICATIONS BEFORE THE FINAL EVALUATION PHASE.

Video/Activity	Planning Part	Integration Format	Outcomes
Short: "Mini Solar Farm in a Box"	**Kick-off(10 min) or energy council**	A small demonstration of a real-life solar energy application. Groups can discuss which technology is appropriate for each country.	Relating real technological examples to geographical conditions.
Short: "Wind Turbine Model"	**Data detective activity (20 min)**	It can be used in conjunction with wind potential in countries. Students discuss the question, "Which country should invest in wind turbines?"	Analyzing renewable resources according to country conditions.
Short: "Hydropower in a Bottle"	**Energy Council Scenario (10 min)**	It can be used as a model technology for countries that use hydropower (e.g., Portugal, North Macedonia).	Comparing different types of renewable energy.

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Energy Efficiency and Energy Saving Steam Plan 4

Teacher Guide and STEAM Lesson Plans

September, 2025

Project Partners

CONTEXT

The scope of this teacher's guide

This teacher's guide addresses the issue of how we should behave towards energy to protect the environment.

It presents two lesson plans to be used in conjunction with a student's worksheet, developed to support a 60-minute class.

The target Group is secondary school students aged 15–17 years old.

Some general information, followed by the lesson plan, is provided for the lesson.

The subjects involved are Science, Technology, Geography, Economics and English.

The keywords that describe the lessons are: energy efficiency, energy saving, renewable energy, sustainability, STEM, and environmental protection

Summary

Students will explore how energy efficiency and conservation protect both the environment and the economy. Through interactive games, small-group problem-solving, real-life examples, and creative project work, students will analyze their own energy habits and propose realistic solutions.

Aims of the lessons

By the end of the teaching and learning sequence, students are expected to show **knowledge** of energy efficiency and energy saving, namely to:

- Define energy efficiency.
- Explain the environmental and economic benefits of the efficient use of energy.
- Identify everyday behaviors and technologies that save energy.
- Compare renewable and non-renewable energy use in terms of efficiency.
- Propose actionable strategies to reduce energy waste at home, school, and in their community.

During the sequence, students will develop **21st-century** skills in the following areas:

- Creativity and innovation
- Critical thinking and problem-solving
- Communication and collaboration
- STEM Literacy:
- Information literacy

Methodological approach

The methodological approach relies on the following **strategies**:

- Collaborative learning (group challenges)
- Inquiry-based and problem-based learning
- Visual/digital learning (infographics, short videos)
- Gamification (energy challenge game)
- Formative assessment (observations, group feedback)

The methodological approach acknowledges a **STEM orientation** by assuming:

- **Personalisation of learning:** reflection on energy saving.
- **STEM topic integration:** Links between energy use, environmental conditions, and economic and societal issues.
- **Formative assessment:** Continuous formative assessment through reflection and peer review.

Assessment guidelines

Assessment is continuously done based on formative practices to personalize learning and enhance the overall teaching and learning experience.

Formative assessment is embedded in the lesson activities. It should be done during class discussions, group work, role-playing, etc. Students' worksheets include a variety of tasks to be performed by the students that allow the teacher to observe progression on knowledge, reasoning, behavior, communication skills, social-relational skills, creativity, etc. They also allow students to express their understanding in different ways, providing evidence of how deeply they understand and can use the content. Formative assessment should consider issues like accuracy of scientific content, creativity in presentation, collaboration and teamwork, critical thinking and clarity of reasoning, communication and argumentation, and engagement with the tasks.

To strengthen active participation, both self-assessment and peer assessment play a central role. Therefore, students are asked to reflect on their learning and contribution to the group, to evaluate their group's collaboration, and the performance of the different groups, etc. In addition to teachers' questions, worksheets include questions with this aim.

Together, these assessment practices provide a holistic view of each student's progress, enabling the teacher to adapt instruction to individual needs while helping students become reflective, self-directed participants in their own education.

Theoretical background

Energy efficiency means using less energy to get the same job done. Being energy efficient means minimizing energy waste to perform a task or provide a service, lowering energy bills, and reducing pollution and greenhouse gas emissions. Many devices, homes, and buildings use more energy than they actually need because of inefficiencies and energy waste. Using energy-efficient light bulbs and insulating a house are examples of energy efficiency measures. There are energy

efficiency codes for electronic devices, which rate products on a scale from A (most efficient) to G (least efficient) to help consumers make informed choices.

Energy Saving refers to the practice of reducing overall energy consumption by changing habits, using energy-efficient technologies, or improving existing processes. While energy efficiency is the ability to obtain the best results by using the least amount of energy resources possible in an activity, energy saving, by contrast, is the ability to reduce the expenditure by promoting limited energy consumption. The primary goal of energy saving is to minimize the use of finite natural resources and fossil fuels, thereby reducing costs, preserving the environment by lowering pollution and carbon footprint, and promoting a more sustainable future for generations to come. One can save energy at home by, for example, making the most of sunlight, that is, opening the curtains or blinds during the day, so sunlight comes in and naturally heats the room, and closing them at night to prevent heat loss; hanging out clothes in the sun or outdoors instead of using the dryer.

More scientific and technical information on these issues can be found at:

https://www.projectgreenlighteu.com/Home/ePlatform?section=energyEff

and in an e-book available at:

https://www.projectgreenlighteu.com/Home/Resources

LESSON PLANS ON ENERGY EFFICIENCY AND ENERGY SAVING (EES)

Time: 120 minutes (2 x 60 minutes)

Teacher's materials: 2 lesson plans

Students' materials: 1 worksheet

Lesson Plan EES1 (60 minutes)

This lesson introduces students to the energy efficiency concept.

1. Brainstorming activity (10 min): Ask your students: *"In your house or school, list three things you think waste the most energy."* Students write privately, then share in pairs, then in class. The idea is to build interest in the topic.

Possible answers (not a single one)

- Leaving lights on in empty rooms
- Old refrigerators or appliances
- Leaky windows or doors letting heat escape
- Computers on standby overnight
- Overusing air conditioning or heating

2. Introduction to energy efficiency (10 min): Show students a short video (2–3 min) about energy efficiency success stories. You can use the video available at https://www.youtube.com/watch?v=mBJysE4EDgY . Ask students what surprised them. Their answers can focus on different issues, and you should acknowledge all of them.

Indicative students' answers

1. **Scale of the Problem**
"I was surprised that the energy sector in Pakistan is expected to contribute 64% of all greenhouse gas emissions by 2050. I didn't realize energy use alone could have such a huge impact."

2. **Impact of Simple Changes**
"It was surprising that simply switching to LED lighting can significantly reduce energy consumption and emissions. Small changes really can make a big difference."

3. **Large Financial Investment**
"I didn't expect that a project like this would cost US$7.4 million. I was surprised by how much investment is needed to make a real difference."

4. **Diverse Application**
"I was amazed that the project isn't just for homes—it also includes commercial, industrial, and outdoor lighting. It shows that efficiency can be applied everywhere."

5. **University Library Example**
"I didn't expect that even a single building, like a library, could be retrofitted with LED lighting and make a measurable impact on energy savings."

6. **Global Support & Collaboration**
"I was surprised that the Global Environment Facility helped fund the project. It shows that international collaboration is important for tackling energy and climate issues."

7. **Speed and Feasibility**
"I was surprised by how quickly LED retrofits can be implemented and the immediate energy savings they produce. It makes efficiency feel achievable."

3. Energy efficiency in Europe Activity (20 min): Ask small groups of 3 to 5 students to carry out the tasks in the Worksheet EES1 and share what stands out, and surprising numbers. Afterwards, promote a class discussion of the groups' answers.

Indicative picks

"EU buildings use 40% of total energy → means buildings are key for savings."
"Switching to LEDs can cut lighting energy use by 75% → easy first step."
"Portugal's renewables already exceed 60% of electricity → shows change is possible.".

4. Design a "Be Energy Smart" Poster (10 min): Ask small groups (3 to 5) of students to design a poster (could be digital or paper) with the top 3 actionable tips for saving energy in school/home, using data from the worksheet. It must include at least one renewable-oriented tip.

5. Gallery Walk + Reflection (10 min): Display students' posters. Ask students to walk around, note 2 tips from others they like. Exit ticket: "One thing I'll change in my home/school to save energy & why."

Lesson Plan EES2 (60 minutes)

This lesson introduces students to the energy-saving concept.

1. Warm-Up Quiz (10 min): Ask students to play a True/False quiz (see bank below). Use the corners of the room, one for True and another for False statements. Explain the false statements.

Quiz, answer and explanation

#	Statement	Answer	Explanation
1	Standby power can use up to 10% of household electricity.	**True**	Phantom/vampire loads add up.
2	LED bulbs last about 25 times longer than incandescent bulbs.	**True**	LEDs can last ~25,000 hours.
3	Leaving a laptop plugged in overnight uses almost no power.	**False**	It still draws power, even when charged.
4	Lowering your thermostat by 1°C can cut heating bills by ~5–10%.	**True**	Small changes save significant energy.
5	Heating water is the largest single use of home energy in Europe.	**False**	Space heating is usually the largest.
6	A fully loaded dishwasher uses less water and energy than hand washing.	**True**	Modern dishwashers are efficient.
7	Keeping fridge doors open briefly has little effect on energy use.	**False**	It forces the compressor to work harder.
8	Solar panels only work in very sunny countries.	**False**	They generate power even in cloudy Europe.
9	Insulating your attic can reduce heating energy by up to 25%.	**True**	Insulation prevents heat loss.
10	Unplugging chargers when not in use doesn't matter.	**False**	Chargers draw small amounts continuously.
11	Switching to public transport or carpooling reduces CO_2 emissions.	**True**	Fewer vehicles → lower emissions.
12	Washing clothes in cold water saves energy without affecting cleaning.	**True**	Detergents today work well at low temps.
13	Turning off Wi-Fi routers overnight damages the device.	**False**	It's safe and saves energy.
14	Large-screen TVs always use less energy than smaller ones.	**False**	Larger screens usually consume more.
15	Using curtains strategically can improve home energy efficiency.	**True**	Curtains keep heat in winter and block sun in summer.

2. School Energy Audit Challenge (15 min): Ask small groups of students to "audit" a classroom/school area (or imagine one) to spot 3 inefficiencies and suggest fixes.
   Ask students to share the result with the class.

Possible inefficiencies and solutions

Area	Inefficiency	Suggested Fix
Lighting	Old bulbs, lights left on	Replace with LEDs, motion sensors
Heating/Cooling	Thermostat too high/low, windows open	Adjust thermostat, close windows, smart thermostats
Electronics	Devices on standby	Auto-shutdown, smart power strips
Insulation	Drafty windows/doors	Seal gaps, insulating film
Water Heating	Excessive heating	Timers, fix leaks
Outdoor Lighting	Lights on during day	Timers, light sensors

3. Role-Play: Community Energy Council (10 min): **Ask small** groups (3 to 5) students to act as councils proposing 3 energy-saving policies or behaviors for their community. Must include a renewable-related tip and cost/benefit idea.

Indicative answer

Policy / Behavior	Renewable-Related?	Cost / Benefit Idea	Explanation
1. Install solar panels on community buildings (schools, libraries, sports centers)	✅ Yes	High upfront cost (~5,000–10,000 per building) but long-term savings on electricity bills; reduces CO_2 emissions	Students can argue that solar panels provide clean energy, reduce utility costs, and serve as a visible community example.
2. Switch all street and public lighting to LED	✅ Optional (indirect)	Medium cost; saves up to 60–70% of electricity for lighting, low maintenance	LED retrofit reduces energy demand, cuts municipal energy expenses, and lowers emissions.
3. Promote carpooling, biking, and public transport	❌	Minimal cost; reduces fuel use, congestion, and emissions	Encourages behavioral change that complements renewable energy investments.
4. Implement an energy-efficiency awareness campaign	❌	Low cost; benefits include energy savings at home and school, increased community engagement	Posters, social media, and workshops educate residents on energy-saving habits.
5. Provide subsidies or rebates for home insulation and efficient appliances	✅ Indirect	Moderate cost for government; households save 20–50% on heating/cooling bills	Encourages private investment in energy efficiency and reduces overall energy demand.

4. Action Plan + Slogan Competition (15 min): Ask small groups (3to 5 students) to draft an action plan and a catchy slogan.

   They should present in 1-minute pitches and vote on "Best Slogan" or "Most Practical Plan."

   As a teacher, you should:

   - Use a timer to keep pitches at 1 minute.
   - Encourage all group members to speak briefly.
   - Create a simple voting system: sticky notes, show of hands, or digital poll.
   - Celebrate creativity in slogans and practicality in plans.

What to Expect From Students

1. **Action Plans**
   - 3 energy-saving actions, usually combining:
     . **Behavioral changes** (turning off lights, unplugging devices, promoting biking/public transport)
     . **Technological fixes** (LED retrofits, smart thermostats, insulation)
     . **Renewable energy measures** (solar panels, small-scale wind, solar water heaters)
   - Plans may include **simple cost/benefit logic**: e.g., "LED bulbs cost 5 euros each but save 20 euros/year in electricity."
2. **Slogans**
   - Short, catchy, easy to remember.
   - Often rhyming or using wordplay.
   - Examples:
     . "Turn it Off, Lighten the Load!"
     . "Bright Ideas, Less Energy!"
     . "Solar Today, Save Tomorrow!"
     . "Share the Ride, Save the Planet!"
3. **Pitch Presentations**
   - 1–minute maximum → concise explanation of actions + slogan.
   - Can include **visuals or sketches** of their ideas.
   - Encourage **enthusiasm and teamwork**.

5. Wrap-Up & Energy Pledges (10 min): Ask each student to select and share one concrete energy-saving pledge for the next month. They can focus on home, school, traveling etc. When they share their pledges, summarize their big ideas.

   The next table shows possible pledges associated with some students' most used places.

   Afterwards, you can find a possible summary of the big ideas that emerge from students' pledges.

Students' possible pledges

Place	Pledge
At Home	• "I will switch all my bedroom lights to LED bulbs." • "I will unplug my phone charger and other electronics when not in use." • "I will reduce my shower time by 2–3 minutes to save hot water." • "I will wash my clothes in cold water instead of warm or hot water." • "I will turn off the TV and computer when I leave the room."
At School	• "I will remind my classmates to switch off lights and projectors when we leave the classroom." • "I will participate in a campaign to replace old bulbs with LEDs in our school." • "I will encourage teachers to close windows when the heater is on."
Community / Travel	• "I will try to walk, bike, or carpool instead of using my car." • "I will encourage my family to install solar panels or use renewable energy where possible."
General / Behavioral	• "I will keep my phone and laptop on airplane mode or turn them off when not in use." • "I will track my home energy usage this month and try to reduce it by 10%." • "I will make a chart at home to remind everyone to turn off lights and appliances."

Big ideas

Many small actions collectively make a big difference.

Behavioral changes (turning off lights, unplugging devices) are easy to implement.

Investing in energy-efficient technologies (LEDs, smart plugs, insulation) saves energy long-term.

Renewable energy adoption (solar panels, clean energy contracts) has both environmental and economic benefits.

Awareness and community engagement multiply the effect of individual actions.

Assessment

Assessment across the lessons is **continuous** and combines **teacher evaluation** with **student self- and peer-assessment**.

Suggested **Teacher Assessment** Strategies:

- Participation in quizzes and activities
- Ability to interpret simple data charts
- Creativity in role-play and slogan design
- Compromise evidenced by the pledge

Suggested **Student's Assessment** Strategies:

- Use **one simple checklist** (for both self- and peer-assessment) after group activities to

reflect on understanding, contribution, and constructive feedback.

- Apply the **Fist-to-Five** technique as a quick formative check during presentations to gauge understanding and engagement.

This streamlined approach ensures meaningful feedback without overloading class time, while encouraging reflection, collaboration, and ownership of learning.

Interdisciplinary Connections of the Topic

The lessons have connections with several subjects, as follows:

- Science: energy efficiency and savings
- Economics: energy costs
- Technology/Art: Use of digital tools for visual communication.
- English: analysis of infographics

ADDITIONAL SUGGESTIONS

PLEASE MAKE THESE APPLICATIONS BEFORE THE FINAL EVALUATION PHASE.

Video/Activity	Planning Part	Integration Format	Outcomes
Short: "Everyday Energy Saving Tips"	**EES1 Course – Introduction to Energy Efficiency (8 min)**	It can be used in the "Successful energy efficiency examples" section.	Günlük yaşamda enerji verimliliği bilgisi.
Short: "LED vs Incandescent Bulb Test"	**EES2 Lesson – Warm-Up Test or Audit Challenge**	It can be cited as an example of energy saving of LED technology.	Organic products, energy components, and recyclable materials are learned through an engineering product, and the increase in sustainability is understood. Design conservation (observe → design → try → develop) is implemented.
Energy saving in school Energy policy	**EES2 – Role Playing Game (Community Energy Council)**	Examples of social energy policies to be implemented in schools and as an example video for energy policy discussions	Analysing the contribution of renewable energy investments to society.
"Energy-Efficient School Project"	**EES2 – Action Plan + Slogan Competition**	Can be used as an inspirational example.	Designing school-based energy efficiency plans.
Engineering for Energy Efficiency	**EES2 Design and Prototype development**	Can be used as an inspirational example.	Students understand the importance of energy efficiency and recyclable materials; the design cycle (observe → design → try)

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Renewable Energy Sources and the Processes of Renewable Energy Production
Steam Plan 5

Teacher Guide and STEAM Lesson Plans

September, 2025

Project Partners

CONTEXT

The scope of this teacher's guide

This teacher's guide addresses four types of energy: solar, wind, hydroelectric, and biomass energy.

It presents lesson plans for each type of energy. These lesson plans are to be used together with the students' worksheets developed to support them.

Each lesson plan was prepared for a 60-minute class and is supported by one or more student's worksheets.

The target Group is secondary school students aged 15–17 years old

The duration of the topic is 9 classes of 60 minutes each

Some general information, followed by the lesson plans (including information on when and how to use the students' worksheets) is provided for each type of energy.

The subjects involved are Science, Physics, Chemistry, Geology, Geography, Computer Studies, Environmental Education / Environmental Studies, Technology, and English.

The number of lesson plans per type of energy is 3 for solar energy, 2 for wind energy, 2 for hydroelectric energy, and 2 for biomass energy

The keywords that describe the lessons are: renewable energy, solar energy, wind energy, hydropower, biomass, sustainable development, electricity production, environmental impact, green technology, clean energy, carbon footprint, energy sources, sustainability, global warming, eco-friendly solutions, green future, energy awareness, STEM education, energy literacy.

Summary

This set of professional teaching plans is designed for students aged 15-17 and offers a comprehensive, interactive, and engaging educational experience aimed at raising awareness and fostering a deeper understanding of four key renewable energy sources. Through this hands-on workshop, students will explore solar, wind, hydroelectric, and biomass energy, discovering how they are produced and their importance for the future. The selection of these four types of renewable energies is based on the most representative renewable sources of energy found in the partner countries of the program – Turkey, Greece, Portugal, and North Macedonia.

Aims of the learning sequence

By the end of the teaching and learning sequence, students are expected to show **knowledge** of renewable energy, namely to:

- Provide a clear and accurate definition of the selected renewable energies: solar, wind, hydroelectric, and biomass energy.

- Identify the energy sources of the four selected renewable energies — sun, wind, water, and biomass.
- Explain the principles underlying the production of the selected renewable energies.
- Compare the advantages, limitations, and potential applications of the diverse renewable sources of energy.
- Evaluate the environmental, economic, and social impacts of adopting renewable energy solutions.
- Design a high-quality, interactive final product (such as a digital presentation, visual poster, or physical model) that promotes awareness and understanding of renewable energy.
- Promote final product-based awareness campaigns for renewable energy use.
- Demonstrate effective teamwork abilities, including equitable task distribution and constructive communication within a group setting.

During the sequence, students will develop **21st-century** skills in the following areas:

- Creativity and innovation in problem-solving contexts
- Critical thinking and analytical reasoning
- Effective communication and collaboration skills
- Advanced information, media, and technology literacy
- Initiative, self-regulation, and a strong sense of environmental stewardship

Methodological approach

The methodological approach relies on the following **strategies**:

- Collaborative and cooperative learning methodologies
- Experiential and inquiry-based learning
- Project-based learning with real-world applications
- STEM-integrated, interdisciplinary approach
- Sustainability-focused educational practices
- Development of media, digital, and visual literacy

The methodological approach acknowledges a **STEM orientation** by assuming:

- **Personalisation of learning:** Students select one of the four renewable energies (solar, wind, hydroelectric, biomass energy) to investigate in depth, based on their personal interests, curiosity, and career aspirations.
- **STEM topic integration:** The sequence integrates concepts from science (energy production and environmental impact), technology (innovative renewable energy systems), engineering (design of energy solutions and models), and mathematics (data analysis, energy efficiency calculations).

- **Hands-on application:** Students engage in practical activities, experiments, and model-building to simulate energy generation processes and measure efficiency.
- **Real-world connections:** Case studies from the partner countries (Turkey, Greece, Portugal, and North Macedonia) illustrate the local application of renewable energy technologies and their socio-economic implications.
- **Assessment:** Continuous formative assessment through observation, reflective journals, and peer review, combined with a final summative evaluation of the group project.
- **Interdisciplinary links:** Incorporation of social studies, geography, and environmental ethics to contextualize the scientific and technological content.

Assessment

Assessment is continuously done based on formative practices to personalize learning and enhance the overall teaching and learning experience.

Formative assessment is embedded in the lesson activities. It should be done during class discussions, brainstorming activities, group work, hands-on experiments, project work, etc. Students' worksheets include a variety of tasks to be performed by the students that allow the teacher to observe progression on knowledge, reasoning, behavior, communication skills, social-relational skills, creativity, etc. They also allow students to express their understanding in different ways, providing evidence of how deeply they understand and can use the content. Formative assessment should consider issues like accuracy of scientific content, creativity in presentation, collaboration and teamwork, critical thinking and clarity of reasoning, communication and argumentation, and engagement with the tasks.

To strengthen active participation, both self-assessment and peer assessment play a central role. Therefore, students are asked to reflect on their learning and contribution to the group, to evaluate their group's collaboration, and the performance of the different groups, etc. In addition to teachers' questions, worksheets include questions with this aim.

Together, these assessment practices provide a holistic view of each student's progress, enabling the teacher to adapt instruction to individual needs while helping students become reflective, self-directed participants in their own education.

Theoretical Background

Energy sources represent the foundation of modern societies, providing the power required for households, transportation, industries, and technological systems. They are generally divided into renewable and non-renewable sources. Renewable energy sources — such as sun, wind, water, and biomass — are naturally replenished, environmentally friendly, and essential for ensuring long-term sustainability. Non-renewable sources — including coal, oil, and natural gas — are finite and heavily associated with greenhouse gas emissions, environmental degradation, and global warming.

This teaching sequence focuses on four key types of renewable energies: solar, wind, hydroelectric, and biomass. Each of these types of energy plays a distinct role in shaping sustainable energy

strategies. Sun's radiation (solar energy), air moving energy (wind energy), and water moving energy (hydroelectric energy) can be converted into electricity. Organic matter can also be transformed into usable energy (biomass energy). While each source of energy has unique benefits, they also present challenges - such as geographic dependence, cost of technology, and infrastructure needs. The process of biomass energy releases methane and CO2, which need to be used for biofuel production to prevent contributing to global warming.

Developing a deeper understanding of these renewable energy sources allows students not only to explore their scientific and technological principles but also to critically evaluate their environmental, economic, and social implications. This theoretical foundation prepares learners to engage actively in the transition towards a more sustainable future. More information is available as follows:

Solar energy: https://www.projectgreenlighteu.com/Home/ePlatform?section=SolarEnergy

Wind energy: https://www.projectgreenlighteu.com/Home/ePlatform?section=Wind

Hydroelectric energy; https://www.projectgreenlighteu.com/Home/ePlatform?section=Hydraulic

Biomass energy: https://www.projectgreenlighteu.com/Home/ePlatform?section=BioMass

More technical information on these types of energy can be found in an e-book available at:

https://www.projectgreenlighteu.com/Home/Resources

LESSON PLANS ON SOLAR ENERGY (Sx)

Time: 180 minutes (3 x 60 minutes)

Teacher's materials: 3 lesson plans, including videos

Students' materials: 3 worksheets, including a list of materials for practical activities

Lesson Plan S1 (60 minutes)

The first lesson introduces students to the concept of solar energy, sparks curiosity through multimedia, and engages them in collaborative classification activities.

1. Motivation (10 minutes): Show a short, engaging video presenting energy sources. A suggested video is available at: https://www.youtube.com/watch?v=bPwvS5V5RW4&t=1s
After watching the video, carry out a brainstorming activity by asking: *"What comes to mind when you hear the word solar energy?"*

2. Introduction to solar energy (15 minutes): Present a clear definition of solar energy—where and how it is produced, what it is used for, how much of it is currently used, and what its future looks like. You can get information on this from: https://www.projectgreenlighteu.com/Home/Resources

3. Application (20 minutes): Hand out Worksheet S1 to students and ask them to take the "True or False" Activity in small groups (question 1).

4. Sharing (10 minutes): Groups share their classifications and explain their answers, especially when they differ from group to group. The teacher summarizes and corrects any misconceptions. The solutions are given below.

5. Reflection (5 minutes): Students answer question 2 of Worksheet S1, and share their reflections.

Solutions for the "True and false" activity (Worksheet S1)

1. False - There are two types of solar panels. Thermal solar panels, which transform the energy from sun rays into heat that is used mainly to warm water; photovoltaic solar panels, which transform energy from sunlight into electricity. This activity focuses on the latter.
2. False – Photovoltaic solar panels work even with indirect sunlight, though efficiency is reduced.
3. True – Solar energy is renewable since the sun is not expected to finish (at a human time scale), and sunlight is continuously available.
4. False – Photovoltaic panels work in winter, as long as there is sunlight; they can be even more efficient in cooler temperatures.
5. True – Opposite to fossil fuels, the energy coming from the sun does not cost money. Technology for harnessing it (as it happens with technology for harnessing fossil fuels) costs some money, but, in the end, using solar energy still reduces electricity bills.
6. True – Electricity from solar energy can be stored in batteries for use at night or on cloudy days.
7. False – Photovoltaic solar panels need very little maintenance, usually just cleaning and occasional checks.
8. False – Manufacturing and recycling photovoltaic panels do cause some emissions, though far less than fossil fuels.
9. True – Large solar farms already power entire communities and cities.
10. False – Solar energy costs have dropped dramatically, making it cheaper than coal or natural gas in many regions.
11. True – Photovoltaic panels can be installed on rooftops, gardens, fields, deserts, and floating platforms.
12. True – Solar energy reduces reliance on fossil fuels and lowers greenhouse gas emissions.
13. False – Photovoltaic panels usually last 25–30 years, with efficiency gradually decreasing.
14. False – Photovoltaic panels lose efficiency in very hot conditions; they perform best in moderate temperatures with strong sunlight.
15. True – The sun is the fastest-growing renewable source of energy used worldwide, surpassing wind in new installations.
16. False– At night, photovoltaic panels cannot generate power because there is no sunlight. At night, the only way to use electricity produced from solar energy is to have it stored in batteries.

Lesson Plan S2 (60 minutes)

The second lesson focuses on applying knowledge of solar energy through a paper-and-pencil scenario-based problem-solving.

1. Motivation (10 minutes): Introduce the scenario to the students; make sure they understand the task.

Scenario: "Your municipality aims to increase its use of solar energy to 40% of its energy mix within 10 years. You are invited to advise on how they can do that."

2. Problem solving (20 minutes): Hand out Worksheet S2 and ask students to do questions 1 to 3, in small groups (3 to 5 students).

3. Sharing (15 minutes): ask the groups to share their proposals (3 minutes per group)

4. Class discussion (10 minutes): Conduct a class discussion of the presentations.

5- Reflection (5minutes): Ask students to think about question 4 of Worksheet S2 and share their thoughts.

Lesson Plan S3 (60 minutes)

The third lesson focuses on applying knowledge of solar energy through a hands-on activity based on a scenario.

1. Motivation (5 minutes): Introduce the scenario in Worksheet S3 to the students.

   Scenario: "At your home, you use electricity, gas, or coal to cook your meals. Have you ever thought about using the sun to cook? Do you think it would be possible? If so, how would it work?"

   Ask students to answer the questions of the scenario (question 1 of Worksheet S3), in small groups (3 to 5 students). If you feel you do not have time to do it in groups, do it in class.

2. Experiment: (30 minutes): Ask students to proceed according to Worksheet S3, from question 2 to 7, in small groups (3 to 5 students). Do not tell them what device they are going to build. Monitor the groups so that they can succeed in building their device and collect and register data in the table provided in worksheet S3. Let them conclude that their device is a solar oven.

3. Sharing and conclusion (15 minutes): ask the groups to share their conclusions.

4. Reflection (5 minutes): Ask students to think about question 8 and share their thoughts.

Alternative experiment to the one in Worksheet S3

If the school has a digital lab that includes solar energy equipment, the teacher can experiment to demonstrate how solar panels work and what key variables affect the panel's efficiency. Students should be cognitively actively engaged in the experiment and analyze the findings obtained.

5. Self-assessment (5 minutes): Invite students to play the games available at https://www.projectgreenlighteu.com/Home/ePlatform?section=SEGames

Assessment in the Solar Energy lessons

Assessment in the solar energy lessons is continuous and integrates both formative and summative elements, aiming at personalizing learning and enhancing the overall teaching and learning experience.

Suggested reflective prompts include:

- What did you already know about solar energy, and which new facts surprised you?
- How effectively did your team collaborate during the experiment?
- Which part of your solar oven design worked best, and what would you improve?
- In which situations do you learn most effectively—through experiments, discussions, or independent research?

Formative teacher-led assessment is conducted through interactive strategies such as:

- *Fist-to-Five*: Students indicate how confident they feel about solar energy concepts.
- *Agree/Disagree Circles*: Used during the *True/False* activity.
- *Think-Pair-Share*: Applied after the video and during scenario discussions.

The final (summative) assessment focuses on the quality and depth of the end products: the *True/False* task and the experiment outcomes. Evaluation criteria include:

- Accuracy of scientific content
- Creativity in presentation
- Collaboration and teamwork
- Critical thinking and clarity of reasoning

Together, these assessment practices provide a holistic view of each student's progress, enabling the teacher to adapt instruction to individual needs while helping students become reflective, self-directed participants in their own education.

LESSON PLANS ON WIND ENERGY (Wx)

Time: 120 minutes (2 x 60 minutes)

Teacher's materials: 2 lesson plans, including videos

Students' materials: 3 worksheets, including lists of materials for practical activities, and wind energy domino cards.

Lesson Plan W1 (60 minutes)

The first lesson introduces students to wind energy, sparks curiosity with multimedia, and activates understanding through a sequencing game.

1. Opening (15 minutes): Tell students that they are going to watch a video and have to jot down 2–3 observations while watching
   The video suggested is: "How do Wind Turbines Work?", which is available from https://www.youtube.com/watch?v=niZ_cvu9Fts If appropriate, they can watch the following one too: https://www.youtube.com/watch?v=QcxT_pv8Ov8
   Afterwards, promote a class brainstorm using the following prompt: "Where are wind turbines most effective and why?" → Record the answers (students' previous ideas) on the board (mountains, coastal areas, offshore) without commenting on them.

2. Introduction to wind energy (15 minutes): Use simple visuals (e.g., Canva slides) to explain the energy conversion chain: wind → kinetic energy → mechanical rotation in turbine → electrical energy via generator. Show and compare pictures of onshore vs offshore turbines. Then, ask students what they think now about what is written on the board, that is, "Where turbines are more efficient and why?" It is time to discuss and correct students' previous ideas.

3. "Energy Domino Game" Activity (20 minutes): Provide each group with laminated domino-style cards (Wind, Turbine, Generator, Grid, Homes, Storage, etc.) and hand out worksheet W1. Ask students to play the game and the tasks given in Worksheet W1.
   Students should at least reach Homes/Schools to complete the main task. The Storage card can be used as a bonus or extension for groups that finish quickly. Encourage groups to justify their sequencing in 2–3 sentences, focusing on how energy transforms at each stage.
   Alternatively, you can ask students to take the quiz available online from: https://projectgreenlighteu.com/Home/ePlatform?section=WEGames

4. Reflection (10 minutes): Ask students to do the exercises in Worksheet W2.
   Students' answers should be corrected, paying special attention to misconceptions.

End with a question: "Thinking of wind energy, what happens when the wind doesn't blow?" Let students conclude that when the wind does not blow, the blades cannot rotate, and the wind turbines do not produce electricity.

Solutions for the questions in Worksheet W2

1.1. False: A turbine generator converts kinetic energy into electricity.

1.2. False: Wind turbines convert kinetic energy from the wind into kinetic energy of the blades and also into sound energy (noise) and thermal energy (or heat, which is dissipated).

1.3. True: Offshore wind farms are located in the sea.

1.4. False: Wind energy does not produce greenhouse gas emissions while generating electricity.

1.5. True: The blades move first and transmit motion to the rotor, which in turn sends it to the generator that will convert kinetic energy into electricity

1.6. True: A turbine generator converts rotational kinetic energy into electricity

1.7. False: Offshore areas are the locations that generally have more consistent winds for turbines

1.8. False: Wind turbines generate some thermal energy (or heat, which is dissipated).

Lesson Plan W2 (60 minutes)

The second lesson promotes transforming knowledge into creation and testing, combining a visual design sprint with a simple turbine experiment.

1. Creative Activity (10 minutes): Ask small groups of students (3 to 5 per group) to create a mini-poster (in paper or canvas) titled: "Wind Energy: Powering the Future". They should follow the instructions on Worksheet W3.

   Encourage creativity: colors, icons, short captions, and clear layout. Ensure that each mini-poster includes all required elements: a statistic, a benefit, a challenge, and visuals.

2. Hands-on Experiment (25 minutes): Ask small groups of students (3 to 5 students) to carry out the windmill experiment, to investigate how wind (from a fan) can make a pinwheel spin and how different distances and angles affect its rotation. Students should follow the procedure described in Worksheet W4 and answer the questions provided.

   For students to learn how to make and operate a pinwheel, you ask them to watch a video at the following link: https://www.youtube.com/watch?v=HN0GxOQMzME

   Encourage students to predict before testing and compare results.

   Emphasize careful measurement of distance and angle.

   If available, students can take photos or videos to support their observations.

3. Presentation & Feedback (15 minutes): Each group shares 1–2 findings. Peers respond with Fist-to-Five (fist = disagree, five fingers = strongly agree with their interpretation).

4. Reflection (5 minutes): Ask students to answer questions in Worksheet W5.

   They should write down one advantage (e.g., is renewable, reduces carbon emissions) of wind energy and one siting challenge (e.g., noise, space use, visual impact) of installing wind turbines in a city or rural area.

   Finally, encourage students to think critically about what they learned about wind energy and to share one personal thought or idea, keeping answers concise.

5. Self-assessment (5 minutes): Invite students to play the games available at https://www.projectgreenlighteu.com/Home/ePlatform?section=WEGames

Assessment

To enhance active participation, self-assessment and peer assessment are emphasized. In the first lesson, students reflect on their reasoning during the "Energy Domino Game" activity and evaluate how their group collaborated to justify their classifications. In the second lesson, students assess their teamwork during the pinwheel experiment and provide peer feedback after the short debate presentations using techniques like Fist-to-Five.

Suggested reflective prompts include:

- What new information did you learn about wind energy that challenged your prior understanding?
- How did your group collaborate during the windmill experiment?
- What design adjustments improved the performance of your pinwheel model?
- How easy did you find it to learn through debate, experimentation, or multimedia exploration? Why?

Formative teacher-led assessment is conducted through interactive strategies such as:

- Fist-to-Five: Students rate their confidence in understanding wind energy concepts.
- Think-Pair-Share: Used after the introductory video
- Traffic Lights: Students self-assess their confidence after the windmill experiment by marking green (understood), yellow (partially understood), or red (need help).

The summative assessment focuses on the quality and depth of the group products and activities, the debate outcomes, and the experimental windmill results. Evaluation criteria include:

- Accuracy of scientific content
- Creativity in problem-solving and experimentation
- Collaboration and effective teamwork
- Critical thinking and clarity in argumentation

Together, these assessment practices provide a holistic understanding of each student's progress. They allow the teacher to adapt instruction to individual needs while helping students become reflective, self-directed learners who can engage critically with renewable energy issues.

LESSON PLANS ON HYDROELECTRIC ENERGY (Hx)

Time: 120 minutes (2 x 60 minutes)

Teacher's materials: 2 lesson plans, including videos

Students' Materials: 2 worksheets, including materials for a puzzle and a list of roles for a role-playing activity

Lesson Plan H1 (60 minutes)

The first lesson unpacks how moving water generates hydroelectric energy, that is, electricity, and engages students in systems thinking with a process puzzle.

1. Opening (10 minutes): Ask small groups of students to discuss how electricity is generated from water. Ask them to share their thoughts.

2. Introduction to Hydroelectric Energy (20 minutes): Ask students to watch a video on hydroelectric energy generation and take notes while watching. The video, "How Hydroelectric Power Works", is available from: https://www.youtube.com/watch?v=q8HmRLCgDAI .

   Ask students to compare what they watched with their previous ideas. Conduct a discussion so that students can understand how hydroelectric energy is generated from water.

   Conduct a brainstorm, asking students, "Where does water have the most usable energy?" (e.g., waterfalls, mountains, rivers).

   Show a quick world snapshot of countries with large hydropower (China, Brazil, Norway). As homework, students research the potential for hydroelectric energy in their country. They should identify major rivers, existing dams, and regions suitable for hydroelectric energy development.

3. Application (20 minutes): Ask students to do the "Hydroelectric Energy Process Puzzle", as described in Worksheets H1.

   The groups place the cards (reservoir, penstock, turbine, generator, transmission lines) in the correct order of energy flow and write what happens at each step. The teacher circulates to help students overcome their difficulties.

4. Reflection (10 minutes): Ask small groups to think about the challenges of using hydropower energy and present their results in 1 minute each. Teacher clarifies ecological issues (e.g., fish migration, sediment build-up, seasonal water flow changes).

Lesson Plan H2 (60 minutes)

The second lesson builds argumentation and design thinking through a debate on a dam and impact-aware infographic creation.

1. Scenario Discussion (5 minutes): Present the scenario provided in Worksheet H2 to the students.

Scenario

"Imagine that your local authorities want to increase the mix of hydroelectric energy. One possibility of achieving that goal is to build a dam. Should our region build a medium dam?"

1. Motivation (10 minutes): Ask students to work in small groups and answer questions 1 and 2 of Worksheet H2, as preparation for the role-playing activity.

2. Role-playing (20 minutes):

This activity combines role-playing and structured debate, allowing students to explore multiple viewpoints and practice evidence-based argumentation.

Start by selecting a student from each group to represent one of the following roles: government, environmental groups, energy companies, tourism agents, or safety agents.

The rest of the class is divided into two teams—Pros and Cons-

Students have to argue for or against the project (to build a dam) by incorporating the perspectives of their assigned stakeholders.

The debate consists of opening statements (2 minutes per side) followed by rebuttals (1 minute per side), while the teacher moderates to ensure equal participation and clarifies any inaccurate ideas.

3. Peer Feedback (10 minutes): After the debate, ask each student to write down one key argument or strong point put forward by a different stakeholder and explain why it was chosen. And to answer question 3 of Worksheet H2.

4. Conclusion (15 minutes): The teacher then leads a quick class summary, highlighting the main arguments from both the Pro and Cons teams and the different stakeholder viewpoints, ensuring students understand the variety of perspectives and the complexity of balancing energy, social, and environmental considerations.

Clues for Pro and Con arguments

Possible Benefits: clean renewable energy, flood control, irrigation, job creation, and energy independence.

Possible Risks: relocation of people, impact on fish and ecosystems, cost, long construction time, and visual landscape changes.

5. Self-assessment (5 minutes): Invite students to play the games available at https://www.projectgreenlighteu.com/Home/ePlatform?section=HEGames

Assessment

In the lessons on hydroelectric energy, formative assessment is embedded in both lessons—during video-based discussions, brainstorming, puzzle tasks, and the role-playing activity.

To strengthen active participation, both self-assessment and peer assessment are consistently applied during small group work, class discussion, and role-playing. Peer feedback methods such as the *Fist-to-Five* technique enable students to develop awareness of evaluation criteria and foster responsibility for their own learning journey.

Suggested reflective prompts include:

- Which new facts about hydroelectric energy surprised you the most?
- How well did your team collaborate during the debate?
- Which task helped you understand hydroelectric energy more effectively?

Formative teacher-led assessment is carried out through interactive strategies such as:

- *Fist-to-Five*: Students quickly indicate their confidence level in understanding hydroelectric energy concepts.
- *Think-Pair-Share*: Used after the video and during the role-playing activity preparation phase.

Summative assessment focuses on the quality and depth of student outcomes in both lessons: the classification task in Lesson 1 and the debate arguments in Lesson 2. Evaluation criteria include:

- Accuracy of scientific content
- Critical thinking and clarity of reasoning
- Creativity in designing and explaining arguments/solutions
- Collaboration and teamwork

Together, these formative and summative strategies provide a holistic picture of each student's progress, while also allowing the teacher to adapt instruction to individual needs and encouraging students to become reflective, responsible, and active participants in their own learning.

LESSON PLANS ON BIOMASS ENERGY (Bx)

Time: 120 minutes (2 x 60 minutes)

Teacher's materials: 2 lesson plans, including videos

Students' materials: 2 worksheets, including a list of materials for practical activities

Lesson Plan B1 (60 minutes)

The first lesson explores what counts as biomass and how energy can be obtained from biomass, using an experiment and a playful classification game to solidify concepts.

1. Opening (10 minutes): Ask students to watch the video: "What Is Biomass?" https://www.youtube.com/watch?v=nVl17JLn_u0
   Promote brainstorming by asking students, "Which household wastes could be useful to produce energy?". This question is expected to lead to an answer mentioning food scraps and garden waste.

2. Introduction to biomass energy (15 minutes): Based on the video, promote a discussion on what biomass energy is, where it comes from, mentioning the main sources such as wood, crop residues, manure, and food waste.
   Emphasize the processes of obtaining energy from these materials, including direct combustion (leading to thermal energy or electricity), and composting (leading to biogas). Ask for examples of everyday uses of biomass energy, such as heating, cooking, and electricity generation, to help students connect the processes to real-life applications.

3. Experiment: (20 minutes): Ask small groups of students (3 to 5 students) to conduct an experiment described in Worksheet B1: inflating a balloon with Biomass. Do not tell them what will happen. Let them feel the sense of discovery.
   With this experiment, students explore anaerobic digestion, a process where microorganisms break down organic matter in the absence of air to produce biogas, such as methane, which can be used to generate electricity.

4. Conclusion (15 minutes): When the experiment is completed, ask students to answer questions 2 to 6 of worksheet B1, to analyze data, and conclude from the experiment.
   This hands-on activity demonstrates the basic principles of biomass conversion and fermentation, showing how microorganisms convert organic matter into energy, and allows students to analyze the roles of sugar, water, and yeast, as well as the environmental conditions that maximize gas production.

5. Reflection (Homework): Ask students to write down the most important thing they learned and oqnueestion they still have.

Lesson Plan B2 (60 minutes)

The second lesson channels creativity into designing a feasible biogas production system and evaluating real-world trade-offs.

1. Warm up Biomass Bingo game (10 minutes): Invite students to play the Biomass Bingo game, using worksheet B2.

   Distribute the cards (annex to worksheet B2) among the students.

   Read items one by one, in random order.

   Correct answers must be confirmed by a quick class discussion, and students' understanding reinforced.

Correct classification of the items in the cards

Suitable for Biomass energy	Not Suitable for Biomass energy
Corn husks	Plastic bottles
Manure	Coal
Olive pits	Natural gas
Wood chips	Gasoline
Food waste	Glass
Straw	Aluminum cans
Sawdust	Steel scrap
Sugarcane bagasse	Oil

2. Creative design of a mini biogas system (25 minutes): Students are asked to plan, on a A3 paper, a mini biogas (production and use) system following instructions in Worksheet B3, questions 1 and 2.

   The design must include: inputs (waste types), digester, gas output, fertilizer byproduct, storage, and possible uses.

   Encourage students to draw arrows, icons, and labels, and Canva icons (optional). Circulate and ask them guiding questions (e.g., "What happens if there's too much food waste at once?").

3. Presentation of the design (10 minutes): After completing the design, each group gives a 60-second pitch of their design. One question from peers per group should be encouraged. Comment on students' designs to correct them if necessary.

4. Reflection (10 minutes): Ask students to get the "Exit ticket", by answering question 3 of Worksheet B3.

   Students should complete the sentence using ideas like the ones below.

"Biomass energy production works best when [*utilizing sustainable and efficient supply chains that avoid competition with food crops and minimize negative environmental impacts*] but we must watch out for [*air pollution and emissions, soil degradation and loss of biodiversity, and carbon neutrality concerns, as biomass burning can still produce significant greenhouse gases and may require unsustainable land use changes*]".

5. Self-assessment (5 minutes): Invite students to play the games available at https://www.projectgreenlighteu.com/Home/ePlatform?section=BMgames

Assessment

Assessment in the biomass energy lessons is continuous and combines formative and summative approaches, aiming to support differentiated learning and maximize student engagement.

Formative assessment is embedded in both lessons—during the introductory video, group brainstorming, classification activities and the biomass energy experiment. Students understanding is actively monitored through worksheets, guided discussions, reflective tasks, and observation of group dynamics. These strategies allow the teacher to identify misconceptions early and help students consolidate their knowledge step by step.

Suggested reflective prompts include:

- What did you already know about biomass, and what new facts did you learn?
- How well did your team collaborate during the classification activity?
- What was the most surprising finding from the biomass energy production experiment?
- If you had to convince a community to use—or not to use—biomass to produce energy, which arguments would you choose?

Teacher-led formative assessment is carried out through interactive techniques such as:

- *Think–Pair–Share*: Used after the introductory video to guide students from personal reflection to group exchange.
- *True /false*: Applied during the "Bingo game" activity to spark dialogue around misconceptions.
- *Traffic Lights*: Used after the experiment to gauge students' level of understanding.
- *One-Minute Paper*: At the end of each lesson, students write down the most important thing they learned and one question they still have.

Together, these assessment methods provide the teacher with a comprehensive understanding of student progress and enable learners to take responsibility for their own learning, while developing critical thinking, creativity and teamwork skills.

Interdisciplinary Connections of the Topic

The lessons have connections with several subjects, as follows:

- Science: Analysis, classification, and comparison of Solar, Wind, Hydroelectric, and Biomass energy sources.
- Geography: Influence of location, climate, and natural resources on energy production and efficiency.
- Economics: Exploration of costs, benefits, and sustainability of different energy technologies.
- Technology/Art: Creation of visual materials and digital presentations using tools like Canva, Genially, and Google Forms.

ANNEXES

Annex 1: Glossary

- **Energy**: The ability to do work or cause change.
- **Types of energy**: have to do with the different ways energy manifests itself: thermal, light, mechanical, and chemical energy.
- **Forms of energy:** are broad classifications of energy which encompass kinetic energy, the energy of motion, and potential energy, due to position or state. Examples include the energy of a moving car (kinetic) and the energy of water stored in a high dam (potential).
- **Renewable Energy**: Energy derived from natural sources that are constantly replenished, such as sunlight, wind, flowing water, and biomass.
- **Non-renewable Energy**: Energy obtained from sources that cannot be replenished on a human time scale, such as fossil fuels.
- **Fossil Fuels**: Energy sources formed from the remains of ancient plants and animals, including coal, oil, and natural gas.
- **Solar Energy**: Energy harnessed from the sun's rays, often captured using solar panels or solar thermal systems.
- **Wind Energy**: Energy generated by converting the kinetic energy of wind into electrical power using turbines.
- **Hydroelectric energy**: Energy produced by using the flow of water to generate electricity, usually through dams or small-scale river turbines.
- **Biomass Energy**: Energy produced from organic materials such as wood, agricultural residues, or animal waste, through burning or composting processes.
- **Sustainability**: Using resources in a way that meets current needs without compromising the ability of future generations to meet theirs.
- **Energy Efficiency**: Using less energy to perform the same task, reducing waste and environmental impact.
- **Energy Saving:** Reducing overall energy consumption by changing habits, using energy-efficient technologies, or improving existing processes.

Annex 2: Checklist for Lesson Activities

- **Definition & Understanding:** Has the student understood and can clearly explain what this specific type of energy is (Solar/Wind/Hydroelectric/Biomass energy)?
- **Classification:** Was the correct categorization made (renewable/non-renewable) and were key characteristics of each category identified?
- **Key Concepts:** Are essential details included (method of production, technologies, current levels of use, prospects)?
- **Pros & Cons:** Are at least two advantages and two disadvantages identified for each energy source use?
- **Environmental Impacts:** Are the positive/negative impacts on the environment accurately described?
- **Real-world Examples:** Are there concrete examples from students' countries/Europe/the world showing practical application?
  - Solar: e.g., Portugal – Solar farm of Amareleja ; Greece – Chronus Kozani Solar PV Park, Turkey – Karapınar Solar Power Plant.
  - Wind: e.g., Wind farm in Mani offshore wind turbines (general example: North Sea); Turkey – Balıkesir Bandırma Wind Farm.
  - Hydropower: e.g., Kremasta Hydroelectric Plant small "run-of-river" facilities.
  - Biomass: e.g., Biomass units in Western Macedonia use of agricultural residues, Turkey – Konya Biomass Power Plant, using agricultural waste.
- **Collaboration:** Was there effective teamwork (role distribution, time management, conflict resolution)?
- **Creativity:** Was creativity incorporated (poster/infographic, role-play, original solutions to scenarios)?
- **Critical Thinking:** Were positions supported with evidence? Were options compared and justified?
- **Use of Digital Tools:** Were Canva/Genially/Kahoot/Google Forms effectively used for research, organization, and presentation?
- **Presentation Skills:** Were the presentations clear, well-structured, and adapted to the audience?
- **Reflection:** Was self- and peer-assessment carried out (e.g., Fist-to-Five, short reflective responses) with clear next steps for improvement?
- **Visual & Communication Clarity:** In visual work, were appropriate images/icons/layouts used to ensure readability and an engaging outcome?

Annex 3: Selected Excerpts from Scientific Articles for Discussion

Excerpt 1

The year 2024 marked a historic turning point for Europe, as solar energy for the first time generated more electricity than coal. Photovoltaic systems supplied around 11% of the EU's total electricity, surpassing the 10% produced by coal. This achievement was not the result of exceptionally sunny weather—in fact, sunshine levels in 2024 were lower than average—but rather the outcome of record-breaking new solar installations across the continent.

At the same time, reliance on natural gas continued to decline, accounting for only 16% of the EU's energy mix, marking the fifth consecutive year of reduction. This trend demonstrates that the transition toward renewable energy can happen faster than expected when technological innovation, political commitment, and strong investment align.

The rapid growth of solar energy also carries broader social and environmental implications. On the one hand, it significantly reduces carbon dioxide emissions and contributes to mitigating climate change. On the other, it strengthens Europe's energy independence by reducing the need for fossil fuel imports. These developments highlight the potential for the EU to move closer to the ambitious targets of the European Green Deal and achieve climate neutrality by 2050.

The example of solar power in 2024 can be used as a case study for classroom discussion, helping students explore not only the benefits but also the challenges of renewable energy. Alongside the advantages, the challenges include energy storage, grid integration, and ensuring that the transition remains fair and inclusive for all.

(adapted from: The Guardian – Rising star: Europe made more electricity from solar than coal in 2024-https://www.theguardian.com/world/2025/jan/22/rising-star-europe-made-more-electricity-from-solar-than-coal-in-2024)

Excerpt 2

The year 2024 marked a significant expansion of wind energy capacity in Europe, with 16.4 GW of new installations, of which 12.9 GW were added within the EU-27. The majority of this growth came from onshore projects (84%), while offshore accounted for 2.6 GW. Altogether, Europe's wind capacity has now reached 285 GW, with the EU holding 231 GW (210 GW onshore and 21 GW offshore).

Looking ahead to 2025–2030, projections indicate the addition of 187 GW of new capacity across Europe, including 140 GW within the EU. This implies an annual growth rate of approximately 23 GW, raising Europe's total wind capacity close to 450 GW and the EU-27's to around 351 GW by 2030. Such growth plays a crucial role in meeting the EU's target of at least 42.5% renewable energy share in the overall energy mix.

These figures highlight not only the rapid technological and market developments but also the importance of policy support, infrastructure upgrades, and permitting processes in driving the

continent's energy transition. Discussing these numbers in the classroom helps students connect real-world data with the challenges and opportunities of shifting towards a sustainable energy future.

(adapted from: WindEurope – Wind energy in Europe: 2024 Statistics and the outlook for 2025-2030 – https://www.dnv.com/energy-transition-outlook/download/?utm_source=googlecpc&utm_medium=search&utm_campaign=eto_2024_download&gad_source=1&gad_campaignid=21616551769&gbraid=0AAAAAo9W8r3DHpYYl0bVThnDhr_FD-JDo&gclid=Cj0KCQjw_L_FBhDmARIsAItqgt5dk05yBPEf0DPVULyFv6s5NOWdAJga3TkXFmcFIBGtSnEq1WNI7HgaAjIHEALw_wcB)

Excerpt 3

Based on the Eurostat article on renewable energy statistics, hydroelectric energy continues to provide a significant contribution to electricity production in the EU. In 2024, hydroelectric energy accounted for approximately 29.9% of the total electricity generated from renewable sources in the EU.

Hydroelectric energy is generated by the impact of moving water on turning turbines. This technology is one of the oldest forms of renewable energy, with historical applications dating back to pre-industrial times, such as water mills. Beyond supplying substantial amounts of renewable electricity, hydroelectric energy can also provide key system services for the European electricity grid, including flexibility and energy storage. These services are essential for maintaining grid stability and integrating an increasingly variable renewable generation mix, such as solar and wind energy.

Hydroelectric energy also contributes to the EU's energy security by reducing dependence on imported fossil fuels and supporting energy autonomy. However, the development of new hydroelectric energy projects can face environmental and social challenges, including ecosystem management and the impacts on local communities.

Overall, hydroelectric energy remains a critical renewable energy in the EU, playing a major role in achieving CO_2 reduction targets and advancing a sustainable energy transition.

(adapted from: https://ec.europa.eu/eurostat/statisticsexplained/index.php?title=Renewable_energy_statistics)

Excerpt 4

Based on the IEA Bioenergy report on biomass deployment in the EU in 2024, biomass remains the largest renewable energy source in the European Union. In 2022, biomass accounted for approximately 60% of the total renewable energy in the EU, with production of energy form biomass reaching 6.1 exajoules (EJ). This significant contribution places biomass at the forefront of renewable energy sources in the region.

Biomass energy production is utilized across multiple sectors, including electricity generation, heating, and transportation. In electricity production, biomass contributes around 6% of total EU generation. In heating, biomass covers roughly 18% of thermal energy use, mainly through direct use

in residential and industrial applications. In the transport sector, biofuels (that is gases obtained from biomass composting) such as biodiesel and bioethanol, serve as important energy sources, with biodiesel representing 7.2% of diesel consumption and bioethanol 4.7% of gasoline consumption in the EU.

Biomass is primarily composed of wood residues, agricultural and forestry residues, and organic waste. This energy source benefits from high domestic production, with the EU having low dependence on biomass imports, unlike fossil fuels. Specifically, dependence on biomass and waste imports for energy use is below 5%, while for fossil fuels, dependence exceeds 70%.

However, the expansion of bioenergy (that is energy obtained from biomass), that is energy obtained from biomass, faces challenges, such as the need for sustainable cultivation practices, ecosystem management, and social acceptance. It is essential to ensure that biomass production does not lead to deforestation or negatively affect biodiversity. The EU has established strict sustainability criteria for biofuels to ensure that bioenergy development positively contributes to the energy transition and the achievement of CO_2 emission reduction targets.

(adapted from: https://www.ieabioenergy.com/wp-content/uploads/2025/01/CountryReport2024_EU27_final_v2.pdf)

Annex 4: Annexes of students' worksheets

Annex to Worksheet W1 - Cards for the Domino Game

1	Generator → Converts mechanical energy into electricity
2	Kinetic Energy → Energy of moving air (wind)
3	Wind → Natural moving air
4	Blades → "Capture" the wind's kinetic energy
5	Homes → Electricity for families
6	Electric Grid → Distribution network
7	Storage Batteries → Store excess of electricity for later use

Annex to Worksheet H1 - Cards for the puzzle on the hydroelectric energy generation process

1	Turbine	
2	Transmission Lines	
3	Penstock	
4	Reservoir	
5	Generator	

Annex to Worksheet B2 - The «Biomass Bingo» Cards

Card 1

Corn Husks	Plastic Bottles	Manure	Coal
Olive Pits	Wood Chips	Natural Gas	Food Waste
Straw	Gasoline	Glass	Sawdust
Sugarcane Bagasse	Aluminum Cans	Steel Scrap	Oil

Card 2

Manure	Aluminum Cans	Corn Husks	Oil
Food Waste	Glass	Olive Pits	Coal
Steel Scrap	Wood Chips	Straw	Natural Gas
Gasoline	Sugarcane Bagasse	Sawdust	Plastic Bottles

Card 3

Straw	Oil	Plastic Bottles	Food Waste
Sugarcane Bagasse	Aluminum Cans	Corn Husks	Sawdust
Coal	Olive Pits	Glass	Gasoline
Steel Scrap	Manure	Wood Chips	Natural Gas

Card 4

Wood Chips	Gasoline	Food Waste	Plastic Bottles
Manure	Sugarcane Bagasse	Aluminum Cans	Straw
Natural Gas	Olive Pits	Oil	Glass
Sawdust	Coal	Corn Husks	Steel Scrap

Card 5

Olive Pits	Sawdust	Plastic Bottles	Corn Husks
Coal	Manure	Glass	Wood Chips
Aluminum Cans	Food Waste	Gasoline	Steel Scrap
Oil	Straw	Sugarcane Bagasse	Natural Gas

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