

# The BLOOM School Box

## Learning Scenario

### Back to the Future

This learning scenario is part of the BLOOM School Box, which consists of a set of learning scenarios combining bioeconomy into science, technology, engineering and mathematics (STEM) subjects.

This resource was developed as part of the BLOOM “Teach bioeconomy!” competition and is one of the winning entries that have been evaluated by an international team of bioeconomy experts and expert teachers. This learning scenario has been developed as part of the BLOOM project.



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## Learning scenario summary

This learning scenario introduces bioeconomy to students and gives them the opportunity to think about what they can do in the future. Linking theory to practice, students are asked to construct their electrical circuits by using various plants and compare their efficiencies.

<b>Subject</b>	<b>Biology, Environmental Science, Chemistry, Physics</b>
<b>Topic</b>	<b>Biobatteries, electricity generated by plants</b>
<b>Age of students</b>	<b>14-17</b>
<b>Preparation time</b>	<b>3 hours (preparation of Prezi, Kahoot quiz, materials for Lab)</b>
<b>Teaching time</b>	<b>8 hours</b>
<b>Online teaching material</b>	Prezi for demonstrating the idea of bioeconomy Padlet to gather ideas of students Kahoot to assess students' knowledge about bioeconomy
<b>Offline teaching material</b>	Plants, water, carbon electrodes, bulb, ammeter-multimeter, soil, insulated wires
<b>Bioeconomy resources used</b>	<ul style="list-style-type: none"> <li>• <a href="https://www.youtube.com/watch?v=Kui-_MOzkTE">https://www.youtube.com/watch?v=Kui-_MOzkTE</a></li> <li>• <a href="https://www.shell.com/inside-energy/back-to-the-future.html">https://www.shell.com/inside-energy/back-to-the-future.html</a></li> <li>• <a href="https://www.plant-e.com/en/">https://www.plant-e.com/en/</a></li> <li>• <a href="https://www.wur.nl/en/newsarticle/Spin-off-Electricity-from-living-plants-.htm">https://www.wur.nl/en/newsarticle/Spin-off-Electricity-from-living-plants-.htm</a></li> <li>• <a href="https://www.ted.com/talks/anil_raj_bringing_power_to_millions">https://www.ted.com/talks/anil_raj_bringing_power_to_millions</a></li> <li>• <a href="https://www.ted.com/talks/greg_gage_electrical_experiments_with_plants_that_count_and_communicate#t-47043">https://www.ted.com/talks/greg_gage_electrical_experiments_with_plants_that_count_and_communicate#t-47043</a></li> </ul>

## Relevant trends

*Relevant trend(s) the Scenario is intended to respond to. E.g. at <http://www.allourideas.org/trendiez/results>*

- **Informal learning:** learning happens in communities and Personal Learning Networks rather than in formal settings like a school. Part of this learning scenario is planned to happen outdoors.
- **Social learning**
- **Growth mindset**
- **Game-based learning:** learning is mixed with games or with game mechanisms
- **Collaborative learning:** a strong focus on group work.

## Aim of the lesson

*What are the main objectives? What will students achieve by the end of the lesson?*

Our future is expected to be based on green energy and bioeconomy will have a crucial contribution to sustainable Earth. This learning scenario introduces bioeconomy to students and gives them an opportunity to exhibit what they can do in the future, generating electricity with plants, as a start.

Students will be introduced to bioeconomy and its potential for a sustainable future. Among other examples of biobased products, generating electricity by plants will be chosen as a project. At the end, students will construct their electrical circuits by using various plants and compare their efficiency.

## Activities

<b>Name of activity</b>	<b>The detailed description of the activity</b>	<b>Time</b>
<b>Introduction to bioeconomy: Potential outcomes</b>	<ol style="list-style-type: none"> <li>Students are given a pre-survey by the teacher.</li> <li>Students are introduced to the concept of bioeconomy via a presentation made by using Prezi.</li> <li>Linear, circular and bioeconomy are distinguished.</li> <li>The potential benefits of bioeconomy and its leading carrier opportunities are underlined.</li> </ol>	1 teaching hour (40 minutes)
<b>Examples of bio(based) products</b>	<ol style="list-style-type: none"> <li>Giving examples of bio-products such as biobatteries, bioenergy, biodiesel, biogas, biomass, biofibre, bioplastics, etc.</li> <li>A quiz over Kahoot to assess students' knowledge.</li> </ol>	1 teaching hour (40 minutes)
<b>Exploration of materials valuable for bioeconomy</b>	<ol style="list-style-type: none"> <li>Students are taken outside the classroom to find out about materials that have the potential of being valuable for the experiment. These can be leaves, plastic bags, cones, remains of animals, etc.</li> <li>Students take photos of the materials they found and come back to classroom (in total 1 teaching hour).</li> <li>In groups, students discuss how the materials found can be beneficial in terms of bioeconomy and create a short report about it.</li> <li>By using Padlet, the groups share their ideas with the class (in total 2 teaching hours).</li> </ol>	3 teaching hours (each 40 minutes)
<b>Electric production by Microbial Fuel Cells and plants:</b>	<ol style="list-style-type: none"> <li>Students are provided the explanation of how batteries work with relevant images and videos:               <ol style="list-style-type: none"> <li><a href="https://www.youtube.com/watch?v=KkRwuM4S8BQ">https://www.youtube.com/watch?v=KkRwuM4S8BQ</a></li> </ol> </li> <li>A video is shown to introduce how electricity could be generated from Microbial Fuel Cells:</li> </ol>	1 teaching hour (40 minutes)

<i>Name of activity</i>	<i>The detailed description of the activity</i>	<i>Time</i>
<b>Pros and Cons</b>	a. <a href="https://www.youtube.com/watch?v=ZotwUJAb8R4">https://www.youtube.com/watch?v=ZotwUJAb8R4</a> 3. A video is shown to introduce how electricity could be generated from plants: a. <a href="https://www.youtube.com/watch?v=Ku1-_MOzkTE">https://www.youtube.com/watch?v=Ku1-_MOzkTE</a> 4. Discussion of advantages and disadvantages in groups.	
<b>Production of electricity from plants in the laboratory</b>	1. Students are asked to setup their own electric circuit with various plants where they might compare electric production efficiency and measure electric current of each by using an ammeter-multimeter. 2. At the end, students test the efficiency of plants in different cases such as lighting a bulb, powering a small motor, charging a mobile phone, etc. 3. Discussion of strengths and weaknesses of this procedure and improvements that can take this to further levels. 4. Students are given a short post-survey to measure their awareness after the lessons.	2 teaching hours (each 40 minutes)

## Assessment

### *What are the main types of assessment used?*

The scenario includes both formative and summative assessment. The following factors can be taken into account:

- Participation of individuals during group work
- Coming up with at least one logical idea regarding the usage of materials collected during the “Exploration of materials valuable for bioeconomy” session
- Quiz results of Kahoot (the percentage of its contribution should be low because students become stressed and excited easily since they are competing with each other as well as time)
- Finding out about an appropriate plant to use as “battery”
- Besides that, there will also be peer assessment among group members (like in the 4th session). This will help students develop their ideas further.

Since there will be an end product that each group creates, **a product-based assessment** also seems appropriate. The product will either be successful and generate electricity or unsuccessful and fail. It is important for each student to test their circuits in other ways such as lighting a bulb.