



What is a Bioeconomy?



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Standards

Arizona

> **6.L2U1.14:** Construct a model that shows the cycling of matter and flow of energy in ecosystems.

NGSS

> **MS-ESS3-2:** Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

Materials

- > PowerPoint
- > Paper
- > Colored Pencils
- > Device with an internet connection to conduct online research

Overview

This lesson introduces students to the concept of a bioeconomy. Students gain an understanding of the environmental impacts and processes of commonly used products.

Grade Level: 6–8

Goals

Students will learn about the concept of a bioeconomy and how a bioeconomy relates to human societies, economic systems, and the environment.

Learning Objectives

Students will be able to define bioeconomy.

Students will be able to differentiate between nonrenewable and renewable sources.

Students will be able to describe the advantages and challenges of creating a bioeconomy.

Students will be able to examine the environmental life cycle of common products.

Students will be able to create an environmental lifecycle of a product.

Students will be able to explain the importance of understanding the life cycle of the products we use.

Vocabulary

Agriculture: (noun) the growing and harvesting of crops and/or raising animals or livestock.

Bioeconomy: (noun) the system of making products derived from renewable materials and trading them for a value.

Consumer: (noun) a person who buys goods or services.

Biodegradable: (adjective) capable of being decomposed (broken down into harmless products or matter) through the action of living organisms.

Carbon Emissions: (noun) the release of carbon dioxide into the atmosphere. Extracting, processing, transporting, and burning fossil fuels like coal, natural gas, and petroleum (oil) release carbon into the atmosphere.

Economy: (noun) the production and distribution of goods and services in a society.

Fossil fuels: (noun) nonrenewable materials that can be used to produce energy (heat or power) that were created from plants and animals that lived millions of years ago. They include coal, oil, and natural gas.

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Vocabulary

Life cycle of products: (noun) the series of stages of a product: from (1) raw materials, (2) production, (3) transportation, (4) retail and usage by consumer, and (5) disposal or recycle into a new product.

Producer: (noun) a person who grows or makes goods and/or offers services.

Non-renewable sources: (noun) things that will run out or will not be replenished for a long time.

Renewable sources: (noun) things that can grow again or never run out.

Set Up

Students will be working in groups of three to four. Each student will need a device and access to the internet to conduct online research. Students should have access to colored pencils (or pens, crayons, markers, etc.) and paper to create posters. Posters/presentations can also be created digitally.

Lesson Procedure

Day 1: Introduction to Bioeconomy

Teacher materials needed: PowerPoint 1: Bioeconomy

Students materials needed: Paper and pencil for notetaking and a device with an internet connection

1. **Introduction (Slide 2):** Introduce today's objectives. (1 min)
2. **Engagement Activity (Slides 3-6):** During this small group scenario activity, students will work together to design a hypothetical bioeconomy using plants and materials found in the Sonoran Desert to create/produce shelter, food, games/recreation activities, and items to trade. Students can conduct research online if necessary. The objective of this activity is for students to create a "bioeconomy," i.e., making products from plants and trading them for a value in the same region. (10 min) Students share what their group discussed. Prompt: Ask students if they would like to trade products with any of the other groups. Emphasize that the purpose of the activity is to create their own economy with the resources that they had available on their planet. (10 min)
3. **Presentation/discussion (Slide 7-12):** Provide students the definition of a bioeconomy and non-renewable and renewable resources. Ask students to name examples of non-renewable and renewable resources before moving to slide 7. In slide 9, ask students to volunteer their ideas about the difference between a bioeconomy and a linear economy. What differences do they see? What are the advantages and disadvantages of each type? (10 min)
4. **Activity (Slides 13-14):** During this activity, students should be in small groups and conduct online research to look for advantages or challenges of creating a bioeconomy. Each group should compile a list of at least two items. Researching the concept of bioeconomy can be time-consuming due to the limited information on this topic. (15 min) Fill out the table called "Advantages and challenges in a bioeconomy" on the PowerPoint (slide 11) in front of the class using the information gathered by the groups. Students should copy this table down. See the example below. (9 min)

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Table: Examples of advantages and challenges of bioeconomies

	Social (humans)	Environmental	Economic (trade/business)
Advantages	<ul style="list-style-type: none"> • Creation of new jobs • Money will stay in the region • Public Health 	<ul style="list-style-type: none"> • Use of fewer toxic chemicals during production • Products could be biodegradable • Decrease in carbon emissions 	<ul style="list-style-type: none"> • Creation of new industries • More effective use of materials
Challenges	<ul style="list-style-type: none"> • Crops commonly used for food could be used to make other products, thus increasing the price of food • Land displacement (using land in a country for the production of goods when the goods are consumed in another country) 	<ul style="list-style-type: none"> • Production of goods could still use toxic products • Deforestation to grow more crops 	<ul style="list-style-type: none"> • Need for new innovations & technologies • Training and development of workforce • Support from institutions, companies and governments

5. **Closure (No slide):** Ask students to reflect on today's topic. What things about these advantages and challenges stand out? How feasible is a bioeconomy in your town? (2 min)

Day 2: Life Cycle of a Product

Teacher materials needed: PowerPoint 1: Bioeconomy

Student materials needed: Paper and pencil for notetaking and a device with an internet connection

1. **Introduction (Slide 15):** Introduce today's objectives. (1 min)
2. **Engagement Activity (Slides 16):** During this think-pair-share activity, students discuss and write down their own ideas in response to the question: What happens to products (computers, smartphones, jeans, tennis shoes, cups, etc.) after we are done with them? The objective of this activity is for students to start thinking about the life cycle of products. (5 min) Students share what their group discussed. (5 min)
3. **Presentation/discussion: (Slide 17-19):** Discuss the definition of an environmental life cycle of a product. Present two examples environmental life cycle of products (plastic straws and sugarcane plates). The slides demonstrate

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the many steps involved in the life cycle of a product. Teachers can use the slides to encourage a discussion about the differences in the life cycles of these two products. (10 min)

4. **Activity (Slide 20):** During this activity, groups of students are provided an object/product, and using internet sources they will diagram and explain the life cycle of their products. The products are a pair of jeans, plastic water bottle, cellphone, organic bamboo straws, teabag, and a palm leaf plate. Each group makes a poster or digital presentation/slide of their product's environmental life cycle. (15 min) Students will then present to the class. (5 min)
5. **Activity (Slide 21):** During this activity, students should work individually and write down their answers to the three questions. The purpose of this activity is for students to reflect on what a bioeconomy is and make a connection between a product's life cycle and the benefits of a bioeconomy. This could be used as an assessment or discussion prompt. (12 min)
6. **Closure (No slide):** Answer any questions and discuss connections to future lessons and topics. (2 min)

Further Exploration (Resources, links, topics, etc.)

- Fossil fuels continue to account for the largest share of U.S. energy. U.S. Energy Information Administration (EIA). (2019) <https://www.eia.gov/todayinenergy/detail.php?id=41353>
- How much plastic actually gets recycled? Life Science. (2020) <https://www.livescience.com/how-much-plastic-recycling.html>
- Product lifecycle assessment shows true environmental impact. Fabricators and Manufacturers Association, International (FMA). (2011) <https://www.fmamfg.org/blog/product-lifecycle-assessment-shows-true-environmental-impact>
- Sustainable Bioeconomies for Arid Regions Center for Excellence <https://sbar.arizona.edu>
- The lifecycle of plastics. WWF. (2018) <https://www.wwf.org.au/news/blogs/the-lifecycle-of-plastics#gs.jea6d2>

Author Biography

Arisbeth Ibarra Nieblas is a third-year doctoral student in Environmental Engineering at the University of Arizona. She majored in Chemical Engineering at the Technological Institute of Sonora (ITSON), Ciudad Obregon, Mexico. Her graduate research involves developing a continuous corrosion monitoring station for water delivery pipe metal. As a third year SBAR Fellow, Arisbeth continues to create educational content for middle school-aged students, including science experiments and activities that involve complex topics like bioeconomy.

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