

RESOURCE LIBRARY

ACTIVITY : 1 HR 40 MINS

Success Stories of Circular Economies

The whole class reads a case study of a circular economic system, using a structured handout to collaboratively unpack the components involved. Then, students partner to read case studies of other successful circular economic systems. They analyze the components of their case studies, identifying strengths and areas for further improvement.

GRADES

6 - 8

SUBJECTS*Biology, Ecology, Engineering, Social Studies, Economics***CONTENTS**

4 PDFs

OVERVIEW

The whole class reads a case study of a circular economic system, using a structured handout to collaboratively unpack the components involved. Then, students partner to read case studies of other successful circular economic systems. They analyze the components of their case studies, identifying strengths and areas for further improvement.

For the complete activity with media resources, visit:

<http://www.nationalgeographic.org/activity/success-stories-circular-economies/>

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DIRECTIONS

***Closing the Loop: Towards a Circular Economy* unit driving question:** How can we make our economy more circular, and why does it matter?

***Closing the Loop: Towards a Circular Economy* lesson driving question:** How can a circular economy minimize harm to the environment and human health?

1. Use a case study of a successful circular economic system to discuss the benefits of circular economies.

- Ask: *We have learned a lot about the idea of a circular economy, and why it's less harmful than a linear economy. But is a circular economy really possible, or is it just a dream? Can you think of any real-world examples that you would call circular economies?* (Responses will vary.)
- Explain that in today's activity, students will learn about several real-world examples, or case studies, of circular economies. None of them are perfect, and all of them have some impacts and wastes, but they are all moving in the direction of more circularity.
- Introduce the National Geographic Explorer Arthur Huang and his important redesign work by showing the [EcoArk](#) video (1:56). Then distribute the article [Turning Trash Into Treasure](#) and guide students through collaboratively reading it as a class.
- Lead a quick debrief discussion to elicit students' initial reactions to the article, emphasizing the connections to the circular economy concepts discussed in the previous unit activities.

2. Model the process of analyzing circular economy components from the case study.

- Display the [Circular Economy Analyzer](#) and distribute one copy to each student. Fill in the word "Polli-bricks" in the blank at the top of the page.
 - Inform students that they will fill out three of these handouts during this unit, including one that will be part of their final product. This one will be completed as a class.
 - Ask: *Does this image look more like a linear economy or a circular economy?* (Possible responses: It looks more like a linear economy because it includes resource extraction and waste; It looks more like a circular economy because it is in the shape of a circle and includes steps, like design and recycling.)

- Tell students that no economic system is perfectly circular because there will always be some wastes created and some raw materials that need to be extracted. The goal is to minimize those impacts and to get as close to a circular economy as possible.
- Point to the arrow that says “Production.” Ask: *What does the article say about how polli-bricks are produced?* (Possible responses: Plastic trash is chopped up and melted down into polli-bricks. A coating helps protect against fire and weather.)
 - Write this information in the corresponding arrow for Production.
- Point to the arrow that says “Use/Reuse.” Ask: *What does the article say about how polli-bricks are used?* (Possible responses: The building is made to withstand earthquakes, typhoons, and heat waves. The polli-bricks protect people inside the EcoArk from wind, rain, heat, and cold.)
 - Write this information in the corresponding arrow for Use/Reuse.
- Point to the arrow that says “Recycling.” Ask: *What does the article say about recycling?* (Possible responses: The polli-bricks are made from recycled plastic bottles. The bricks could be recycled again using the Trashpresso process of shredding, washing, drying, melting, and molding.)
 - Write this information in the corresponding arrow for Recycling.
- Ask: *Are there any other sections of this analyzer that we could fill in based on the article or based on your own prior knowledge?* (Possible responses:
 - In the Design arrow, we could write that Huang and his team invented a way to reshape and strengthen melted plastic chips into building blocks. These polli-bricks have grooves so they fit together and lock in place securely. Air in the bricks insulates the building and keeps energy use low.
 - In the Collection arrow, we could write that one and a half million plastic bottles were required to build a nine-story building.
 - In the Wastes arrow, we could write that the EcoArk and the Trashpresso machine both run on renewable energy, so they do not produce any carbon emissions as wastes.)
- Ask: *Are there any areas of this template that we cannot fill in based on the information we have?* (Possible responses: There is no information about how polli-bricks are distributed;

There is no information about how polli-bricks are repaired; There is no information about how the raw material for plastic is extracted.)

- Fill in any blank arrows with the phrase “More research is needed.”
- Lead students in collaboratively answering the analysis questions on the second page of the *Circular Economy Analyzer*.
 - Follow students’ thoughts and ideas. Use the *Circular Economy Analyzer: Polli-Bricks Answer Key* to prompt their thinking if needed.
- Have students store this template in their project folder. Tell them that in the next activity, they will work with a partner to fill out another template based on a different case study, and they can use this example to help them.

3. Provide circular economy case studies for students to analyze in small groups.

- Emphasize that students may now appreciate how necessary it is for our society to transition to a more circular economy in all aspects of life. Fortunately, many people are already working on solving this problem for all kinds of products, from food and clothing, to furniture and transportation, and beyond.
- Organize students into pairs and distribute a laptop or tablet and two copies of the *Circular Economy Analyzer* to each pair.
 - Distribute or provide access to the *Circular Economy Case Studies* document; students can either choose one that sounds interesting to them, or you can assign so that each case study is reviewed by at least one group.
 - Have groups read through their case study and use the information from the case study to complete both sides of their template.
 - Caution students that their case study may not include all of the information included on the analyzer handout. For some parts, they may need to do more research as time allows. Some of the case studies have links to pages where more information can be found. For other case studies, students may need to make an educated guess, or simply write “More research is needed” on their handout.

4. Assess students’ progress toward understanding the principles of circular economics by having them share their case study analyses.

- In each pair, have one student stay in place to present their case study, while the other student conducts a gallery walk around the room to learn about other groups' case studies. Circulate while students are presenting to understand key themes across their presentations. Press students to identify how the circular economy of their case study helps to minimize negative environmental and human health impacts.
- After a few minutes, have students switch roles.
- Ask: *What similarities and differences did you notice among the different case studies?*
 - Emphasize how there are common themes, but different types of products and systems require creative solutions to make them more circular than linear.
- Now that students have learned about several different case studies of circular economies, revisit the *Know and Need to Know* chart from the activity *There's No Such Place as Away*. Ask: *What changes can we make to this chart now?*
 - Key ideas from this activity and the handouts from the *Beyond the Three Rs* activity include:
 - We now know that many circular economies require creative thinking and collaboration.
 - We now know that many of the concepts of circular economics are already familiar to consumers, such as repairing broken items, collecting scrap materials for recycling, and using apps to help people share their belongings.
 - Students' questions for the "Need to Know" column may include:
 - We need to know what the challenges and obstacles are to improving the circular economies for lithium-ion batteries and electronic waste.
 - We need to know what systems already exist to make the economy for cell phones and electronic waste more circular.
- Have students store their completed analyzers in their project folders, which should now contain two completed analyzers as well as their *Final Product Checklist and Rubric*.

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Tip

Step 1: For more best practices about how to engage your whole class in a read-aloud, consider reading the articles [Strategies for the Classroom](#) and [Taking the Time to Read Aloud](#), and the blog post by Edutopia, [Collaborative Strategic Reading \(CSR\): A Comprehension Strategy to Enhance Content Area Learning](#).

Step 1: Consider emphasizing the concept of upcycling, which is discussed in the article, connecting it to the [Zero-Waste Hierarchy](#) infographic from the *Beyond the Three Rs* activity. Elicit students' ideas of other examples of upcycling that they could create, and share a few examples of upcycled and downcycled products to use as visual aids.

Step 2: To save time, consider distributing the *Circular Economy Analyzer* handout while students are reading the article. They can then fill in the analyzer as they read.

Step 2: For “Raw Material Extraction,” consider providing students with the key steps of the plastic production process from the *Circular Economy Analyzer: Polli-Bricks Answer Key* and discuss with students what kinds of resources they could use to research these kinds of questions (in preparation for Step 3).

Step 3: Depending on time constraints in your class, there are several options for how students can answer the analysis questions on the second page of the *Circular Economy Analyzer*. Students can answer them individually, in small groups, or in jigsaw fashion.

Modification

Step 1: Instead of having the class collaboratively read the *Turning Trash Into Treasure* article, use the Read Aloud feature to support students in reading individually or in small groups.

Step 3: To facilitate students' interest and engagement, consider having them choose a different case study from the [Case Studies](#) page of the Ellen MacArthur Foundation website. This website contains links to nearly 100 case studies of successful circular economic systems

from around the world but vary in terms of their reading level and supporting resources.

Informal Assessment

Students' participation in class discussions and their responses to the analysis questions on the *Circular Economy Analyzer* demonstrate that they can explain the benefits of a circular economy compared to a linear economy. Their completed *Circular Economy Analyzer* provides evidence of their ability to evaluate design solutions that minimize environmental and human health impacts.

Extending the Learning

Have students learn about other case studies, including two designed by National Geographic Explorer [Marissa Cuevas Flores: Kitcel](#), a biodegradable varnish made from discarded Styrofoam, and [MicroTERRA](#), which upcycles wastewater for use in tilapia aquaculture.

Challenge students to find more information about the many environmental impacts associated with extracting petroleum, the raw material from which plastics are made. Some resources they could use to explore this topic further include: [Petroleum](#) encyclopedic entry, [Science 101: Plastics, From Oil to Plastic](#), [An Ocean of Oil](#), and [seven ways oil and gas drilling is bad for the environment](#).

OBJECTIVES

Subjects & Disciplines

Biology

- [Ecology](#)
- Engineering

Social Studies

- Economics

Learning Objectives

Students will:

- Analyze real-world examples of circular economies in order to contrast a circular economy with a linear economy.

- Evaluate the strengths and weaknesses of a circular economy case study, in terms of circularity and impacts on the environment and human health.

Teaching Approach

- Project-based learning

Teaching Methods

- Cooperative learning
- Guided listening
- Reading

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
 - Learning and Innovation Skills
 - Critical Thinking and Problem Solving
- 21st Century Themes
 - Environmental Literacy
 - Global Awareness
- Critical Thinking Skills
 - Analyzing
 - Applying
 - Evaluating
 - Understanding
- Science and Engineering Practices
 - Constructing explanations (for science) and designing solutions (for engineering)
 - Obtaining, evaluating, and communicating information

National Standards, Principles, and Practices

- **Standard 11:**

The patterns and networks of economic interdependence on Earth's surface

- **Standard 14:**

How human actions modify the physical environment

- **Standard 16:**

The changes that occur in the meaning, use, distribution, and importance of resources

NATIONAL SCIENCE EDUCATION STANDARDS

- **DCI ESS3.A:**

Natural Resources: Humans depend on Earth's land, ocean, atmosphere, and biosphere for many different resources. Minerals, fresh water, and biosphere resources are limited, and many are not renewable or replaceable over human lifetimes. These resources are distributed unevenly around the planet as a result of past geologic processes.

NEXT GENERATION SCIENCE STANDARDS

- **Crosscutting Concept 5:**

Energy and matter: Flows, cycles, and conservation

- **MS-ESS3: Earth and Human Activity:**

MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment

- **Science and Engineering Practice 8:**

Obtaining, evaluating, and communicating information

Preparation

What You'll Need

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per pair

PHYSICAL SPACE

- Classroom

GROUPING

- Large-group instruction
- Large-group learning
- Small-group learning
- Small-group work

ACCESSIBILITY NOTES

Review the case studies ahead of time to preview the reading levels and strategically assign students. Strategies include: mixed-ability peer reading groups, focused reading based on the prompts and questions in the *Circular Economy Analyzer*, and providing scaffolding and supports for interpreting new vocabulary and concepts.

BACKGROUND & VOCABULARY

Background Information

To move towards more sustainable practices of global resource consumption, the concept of a circular economy can (and should!) be applied to many different types of industries, as highlighted in the case studies in this activity. Applying the foundational principles of continuing to use products and the materials of which they are made, designing processes and products that minimize waste and pollution, and regenerating natural systems can result in novel innovations for those industries, especially in regards to leveraging technology to redesign products, systems, and processes.

In support of these kinds of innovations and broad-scale systemic changes in a variety of industries, an ideal first step is to apply *some* of the circular economy principles to a historically linear economy, especially for non-renewable resources. As emphasized in this activity, no economic system is perfectly circular, because there will always be some wastes created and some raw materials that need to be extracted. The goal is to minimize negative environmental and health impacts and to get as close to a circular economy as possible, rather than enforcing a strict binary between circular and linear. Individuals and systems must be synergistically involved to rethink and fundamentally shift how we collectively produce, consume, and dispose of material goods in our everyday life.

Prior Knowledge

Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
circular economy	<i>noun</i>	a system of production that extends the lifespan of consumer goods by maximizing reusing and recycling, and minimizing throwing things away.
collection	<i>noun</i>	gathering used materials for recycling or waste disposal.
distribution	<i>noun</i>	the way something is spread out over an area.
downcycling	<i>verb</i>	recycling material to make a product that is of lower quality than the original.
linear economy	<i>noun</i>	system where raw materials are collected and transformed into products, which are eventually discarded as waste.
production	<i>noun</i>	making or manufacturing of a product from parts or raw materials.
upcycle	<i>verb</i>	to recycle one or more items to create an object that is worth more than the original product.
waste	<i>noun</i>	material that has been used and thrown away.

For Further Exploration

Websites

- [Global Aquaculture Advocate: Mexican startup offers DIY aquafeed solution by upcycling wastewater](#)
- [Impact Journalism Day: 'Kitcel', Mexico: biodegradable varnish from Styrofoam waste](#)

