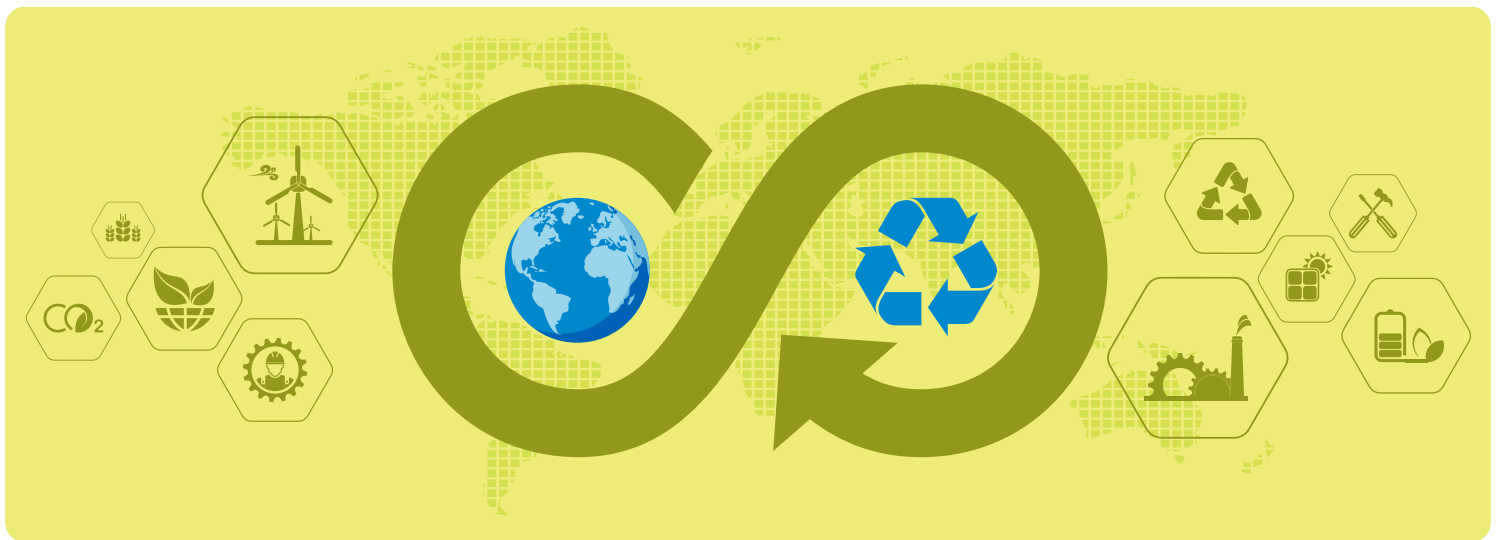# The Tech for Global Good Circular Economy Challenge

Grade Levels: 7-12 | Duration: 4 sessions (60 min each)

In this lesson, learners consider the challenge of developing a circular economy. Each team of learners develops and presents ideas for sustainable approaches to how items are made and used.

Outline

Session 1: Frame the Challenge	**60 min**
This first session sets the stage for the challenge. Teams research the problem and begin brainstorming solutions.	
Session 2: Develop Solutions	**60 min**
Teams develop solutions, and give and receive feedback.	
Session 3: Iterate	**60 min**
Teams refine their ideas and present them to others for feedback.	
Session 4: Present	**60 min**
The project culminates as teams present their ideas.	

Grade Levels: 7-12

Duration: 4 sessions (60 min each)

Concepts/Skills
Sustainability, environment, linear and circular economy, brainstorming, problem-solving, communication, systems design

Objectives
Learners will:
- Describe the difference between a linear and circular economy.
- Create plans for shifting an item from a linear to a circular economy.
- Refine their solution based on feedback from another team.
- Present their ideas to communicate the problem, the solution, and its potential impact.

The Bowers Institute

Materials and Preparation

Materials

- Devices on which learners can watch videos (1 per team of 3-6 learners)
- Sticky notes (1 set of 3 colors per team)
- Chart paper
- Tape
- Markers, pen/pencil, and other writing utensils
- **Circular Economy Project Guide** (1 per learner)
- **Product Life Cycle cards** (1 set per class or team)
- *Optional*: large dry erase boards (1 per team)

*All resources connected to this lesson can also be found at **The Tech for Global Good: Circular Economy webpage**.

The Tech for Global Good videos **"2022-23 Tech for Global Good,"** The Tech Interactive, YouTube (playlist)		

- 4 videos based on the 2022 The Tech for Global Good laureate **Strawcture Eco**
  – **The Problem** (2:08 min)
  – **The Innovators** (2:26 min)
  – **The Solution** (2:21 min)
  – **The Impact** (1:41 min)
	- 4 videos based on the 2022 The Tech for Global Good laureate **Goodr**
	  – **The Problem** (1:58 min)
	  – **The Innovators** (2:25 min)
	  – **The Solution** (1:33 min)
	  – **The Impact** (1:08 min)
		- 4 videos based on the 2022 The Tech for Global Good laureate **MicroByre**
		  – **The Problem** (2:37 min)
		  – **The Innovators** (3:01 min)
		  – **The Solution** (2:14 min)
		  – **The Impact** (1:44 min)

Preparation

1. Watch all the videos to become familiar with the examples.
   - 4 Strawcture videos *(Approximately 8 min total)*
   - 4 Goodr videos *(Approximately 6:30 min total)*
   - 4 MicroByre videos *(Approximately 9 min total)*
2. Divide learners into teams of 3-6.
3. Print, set up, and organize materials for learner mind-map, brainstorming, and presentations.
   - Print Circular Economy Project Guides.
   - Pre-cut the Product Life Cycle cards.
     - *Option*: Print one set per team if you have extra time for the activity.
     - *Tip*: Laminate each set for future use.
   - Determine the format, process, and audience for learner presentations.

Presentation Options

Presentations can vary from being an informal class discussion to a formal event. Choose a style and tools that fit your resources and focus. When possible, involve learners in the planning and process, especially if you are able to invite additional audience members to attend.

Product Format	Audience
• Posters • Slide decks • Videos • Online format: document, web page, etc. • Accompanying prototypes (storyboards, 3D models, diagrams, infographics, etc.)	Consider inviting additional audience members to the presentations, such as: • Another group of learners. • Family and friends. • Professionals or community stakeholders (*For example*: manufacturers, councilmembers, product designers, etc.).

Process
• **Gallery Walk:** Each team sets up a table or poster with their presentation information. Half of the class presents while the other teams move around the room and provide feedback. After a set time period, teams switch roles. • **Class Presentations:** Teams take turns standing up in front of the class and presenting their ideas with accompanying visual aids (posters, slide decks, etc.). • **Panel:** A panel of special guests provides additional targeted feedback on the team presentations. • **Asynchronous:** Teams share their work online (via web page, documents, or videos) and receive feedback via an online form. Consider combinations of these options as well (*For example*: presentations, followed by an untimed gallery walk).

Adaptations for Distance Learning

- Have learners review The Tech for Global Good videos asynchronously.
- Use an online collaborative tool for brainstorming and creation (i.e., Jamboard, Slides, Padlet, Seesaw, etc.).
- Have teams or learners develop their solutions asynchronously and come back together for feedback and presentations.
- Invite special guests to a virtual presentation and celebration.

For more tips on adapting Design Challenges to a virtual setting, see our **Educator Tips for Remote STEM Learning**.

Background Information

The Tech for Global Good

Tech for Global Good

The Tech for Global Good is an initiative that prepares the next generation of innovators to tackle the toughest challenges facing our planet. Every year, The Tech recognizes innovators who use technology to improve lives. Their stories are the inspiration for The Tech for Global Good Design Challenges. These design challenges engage learners in taking a systematic and empathetic approach to addressing social and engineering problems faced around the world.

This lesson profiles three organizations creating a more sustainable future.

- **Strawcture Eco**, a 2022-23 The Tech for Global Good Laureate, provides 100% biobased composite building panels made from agri-residue (straw that would otherwise be burnt or disposed of) to reduce the carbon footprint of the built environment.
- **Goodr**, a 2022-23 The Tech for Global Good Laureate, is on a mission to end food waste, fight hunger, and feed communities using the power of technology and logistics. They have served food to 30 million people in need while diverting nearly four million pounds of food away from landfills.
- **MicroByre**, a 2022-23 The Tech for Global Good Laureate, is turning bacteria into climate-friendly factories. To achieve this, they rely on robotics and automation to rapidly measure and catalog bacteria. This data is used to determine which bacteria can help transform bio-waste into life-saving cancer drugs, jet fuel, fertilizer, and other chemicals. Their production methods will one day break our reliance on petroleum and radically reduce our carbon emissions.

Systems Design Challenges

Systems Design Challenges present learners with a real-world problem that is part of a complex system. Learners examine the intricate parts of that problem as they design potential solutions. By the end of a systems design challenge, learners will be able to articulate a potential solution, the real-world problem it addresses, and the effects their idea might have on other components of that larger system. Systems Design Challenges use the Innovation Design Process and Innovator Mindsets. This focus on the process builds learners' problem-solving capacity and self-confidence, preparing them for careers of the future and empowering them to create change in the world.
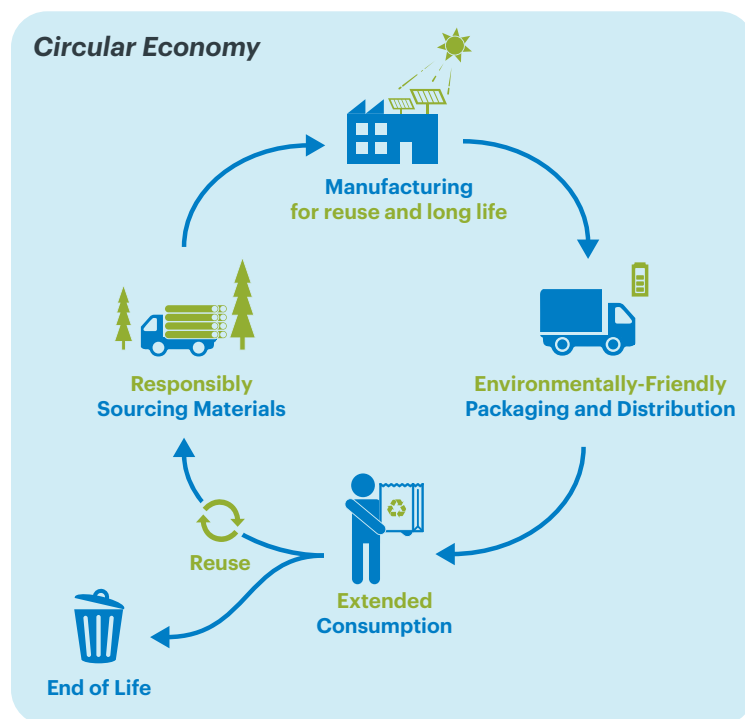
Circular Economy

In this lesson, learners look closely at the life cycle of products and the economic, social, and environmental systems within that process. The traditional production process is often called a **linear economy**. It is based on the idea that natural resources are extracted from the environment, manufactured, consumed, and then disposed of at the end of their life. However, this process has harmful effects on both the environment and humans at every stage.

Linear Economy

Sourcing Materials → Manufacturing → Packaging and Distribution → Consumption → End of Life

There have been attempts in the past few decades to try to disrupt this linear process and develop more sustainable approaches to product development and manufacturing. The idea of a **circular economy** is that sustainability is planned into product development from the very beginning and considered at each stage of the process. The Ellen MacArthur Foundation highlights three principles for a circular economy: eliminate waste and pollution, circulate products and materials (at their highest value), and regenerate nature (see Resources below).

The definitions and approaches to a circular economy vary. As with all systems, the processes can become more complex the closer you examine them. For this lesson, help learners focus on the larger concept of sustainability throughout the life cycle of a product. There may be several opportunities for building circularity into the life cycle of a product; learners can choose to focus on one.

Circular Economy

Manufacturing for reuse and long life

Environmentally-Friendly Packaging and Distribution

Extended Consumption

Reuse

End of Life

Responsibly Sourcing Materials

Circular Economy Resources

- **"Explaining the Circular Economy and How Society Can Re-think Progress,"** Ellen MacArthur Foundation video *(3:48 min)*
- **"Module 1: Moving from the linear to the circular economy,"** Circular Economy video *(2:52 min)*
- **"What is a Circular Economy?"** Ellen MacArthur Foundation website
- **"Here's How a 'Circular Economy' Could Save the World,"** National Geographic website
- **"How Can China Build a Circular Economy for Mobile Phones?"** World Economic Forum website
- **"Teaching Resources,"** Ellen MacArthur Foundation website
- **"Circular Classroom,"** Circular Classroom website

Activate Prior Knowledge *(10 min)*

1. Introduce learners to The Tech for Global Good program. Tell learners that during this project they will have the opportunity to design a solution to a global problem that uses technology to benefit both people and the planet.

2. Let learners know that in this lesson they will examine the systems used to make things.

   - In nature, living things have a life cycle — birth, growth, death, and decomposition. Consumer products also have a "life cycle," requiring the input and output of resources or waste.

3. Invite learner responses and lead a short discussion of what they already know about how things are made.

   Guiding Questions:
   - *Where do the materials that make the things we use come from?*
   - *How does the process of extracting, moving, and preparing these resources affect people or the environment?*
   - *What happens to the things we make when we are finished using them?*

4. Learners may mention the depletion of natural resources, pollution from factories, or issues with waste management. They may be familiar with problems related to food waste or plastic. Let them know that during this lesson they will create innovative ways to address some of these issues.

| Session One	60 min total
Activate Prior Knowledge	10 min
Life Cycle of a Product	15 min
Brainstorm: Transform and Disrupt	15 min
Share and Debrief	20 min

Life Cycle of a Product *(15 min)*

1. Next, learners will look more closely at the complex systems that create some of these problems.

2. Let them know that as a class you will map out the steps used to create an example product (cell phones) and the impact of that process, reflecting on the inputs and outputs of that process.

   - *Note*: The information provided in the product life cycle cards focuses on cell phones. If you are interested in using a different product for this activity, see the **Product Life Cycle Resources** for some ideas.

3. Make sure you have the **Product Life Cycle cards**, markers, chart paper/board, and tape.

   - Begin by spreading out the "Life Cycle Stage" cards (Sourcing Materials, Manufacturing, Packaging and Distribution, Consumption, End of Life) in a horizontal line on the chart paper or dry erase board in no particular order.t

   - Take a moment to discuss and define each of these terms.

   - Have learners help you determine the logical order of these steps.

Sample Mind Map: As students begin to place their cards in the activity it may look something like this.
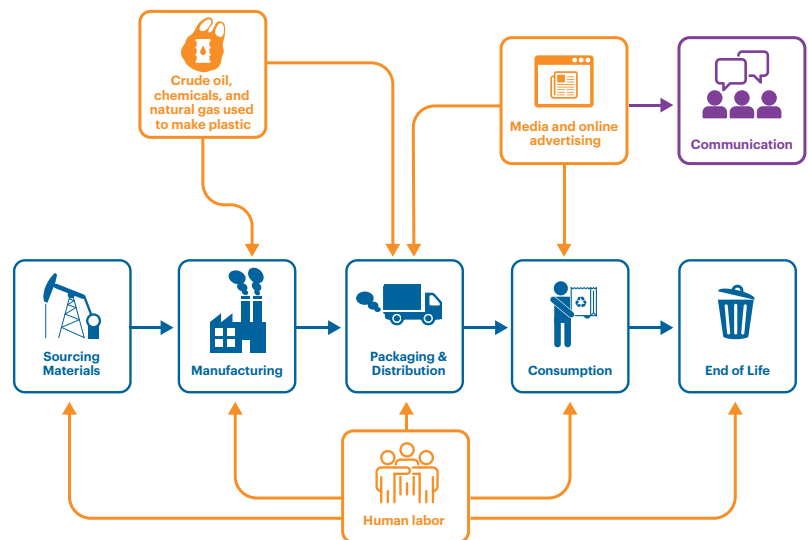
💡 **Option**: If you have more time, have learners do the remainder of the activity in small groups.

Give each group their own set of cards and chart paper. Have them create a mind-map showing the process. When they are finished, teams can share their mind-maps and examine them for similarities and differences.

4. Next, hold up one of the smaller "Resources" cards.
   • Ask learners to help you determine where they think it would go in the process.
   • Tape the card up on the chart paper or board, drawing lines to the stage it is most connected to.
   • Ask learners if they know anything else about this material. Write keywords or draw images based on what they share.
   • Demonstrate this same process with one of the "Impact" cards.

5. Pair learners with each other and hand out the remaining Resources and Impact cards. Each pair should think about where their cards might fit into the process and add it to the group mind map on the board.
   • Encourage pairs to add their cards to the mind-map, draw pictures, write keywords, and add lines showing how their ideas are connected. Allow learners to add additional ideas with post it notes if desired.

6. Give the class about five minutes to complete the mind map. When the time is up, they should have a rough outline of a linear economy.

7. Bring the class back together for a debrief and discussion.
   • Have a few volunteers share what they added.
   • Point out the **linear economy** and define the term with learners. Help them notice the ripple effects of the linear economy on other aspects of the environment and even their own lives.
   • Ask: *How do you think this linear system affects humans and the natural world?*
   • During the discussion, point out:
     – This approach depletes natural resources, which in turn affects the environment. *For example:* Logging for trees affects air quality.
     – This approach results in a large amount of waste and pollution.

🔄 **Product Life Cycle Resources**
   • "**How We Make Stuff,**" Ellen MacArthur website
   • "**The Story of Stuff**," The Story of Stuff Project, YouTube *(21:17 min)*

Cell Phones and Electronics
• "**The Lifecycle of a Cell Phone**," St. Clair County website
• "**The Mobile Phone Lifecycle**," SMART website
• "**The Life Cycle of a Cell Phone**," Wirefly website
• "**The Story of Electronics**," The Story of Stuff Project, YouTube *(7:47 min)*

Bottles and Cups
• "**What really happens to the plastic you throw away - Emma Bryce**," TED-Ed website *(4:07 min)*
• "**Life Cycle Assessment (LCA) of Reusable and Single Use Coffee Cups**," Recyc-Quebec website
• "**Story of Bottled Water**," The Story of Stuff Project, YouTube *(8:04 min)*

Clothing
• "**The life cycle of a t-shirt - Angel Chang**" TED-Ed website *(6:04 min)*
• "**The life cycle of a pair of jeans - Madhavi Venkatesan**," TED-Ed website *(4:34 min)*
• **Planet Money Makes a T-Shirt, the world behind a simple shirt in five chapters**, NPR website with videos

Extension

Have learners choose an existing product they are interested in and research the life cycle of this product. This product can then be used as the basis for their solution in the next session. Have them consider:

- *Where do the resources that make this come from?*
- *What is the impact of gathering the resources to make this?*
- *What materials is the item made of?*
- *How is the item produced?*
- *What resources are used to make it?*
- *How is the item packaged? What is that packaging made of?*

- *Where and how does transportation and delivery happen?*
- *What happens to the item when someone is finished using it?*
- *Where is money spent and gained in this system?*
- *Who makes money?*
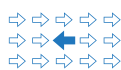- *Where are resources used and lost?*

Brainstorm: Transform and Disrupt *(15 min)*

1. Tell learners that next they will have a chance to think about how they could disrupt or change this system. Let them know they will try to think of more sustainable approaches to this process.
2. Organize learners into teams of three to six. Hand out the **Circular Economy Project Guides**.
3. Hand out a set of sticky notes and pens/pencils to each team. Tell them that the activity will have two rounds.
   - **Round 1 - Transform:** Pick a material from the life cycle and think of a way to use all or part of it for a different purpose.
     - *For example*: Paper packaging is recycled to create paper plates.
   - **Round 2 - Disrupt:** Pick a stage of the life cycle and think about what its purpose is and come up with a completely different way to achieve the same purpose (ideally in a more sustainable way).
     - *For example*: Print advertising becomes a viral social media campaign.
4. Set a timer and give learners five minutes for each round.
   - Encourage them to come up with as many ideas as they can in each round.
   - They should write one idea on each sticky note and can use drawings as well.
5. After Round 2, have team members share their ideas with each other.
6. Each team can select three of their favorite ideas to share with the rest of the class.
   - Make sure they take notes on their favorite ideas on page 2 of their **Circular Economy Project Guides** to return to later.

Brainstorming Tech Tip

Remind teams that during brainstorming, all contributions are encouraged.

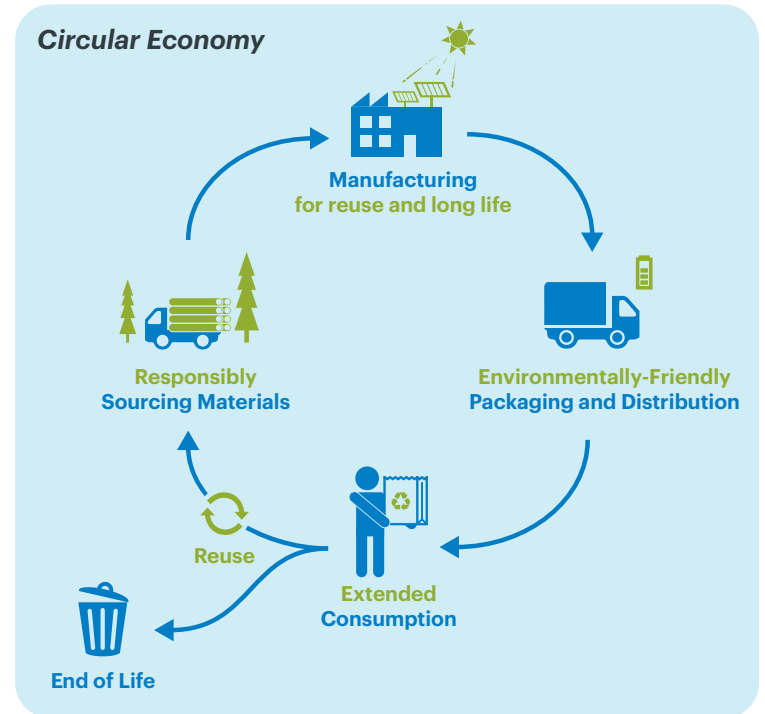- Think of wild ideas.
- Go for quantity over quality.
- Be creative!

For suggestions on structuring a brainstorm session see PDF and video Tech Tips for Facilitating Brainstorming on our **Explore Design Challenge Learning** webpage.

Debrief and Share *(15 min)*

1. Bring teams back together for a debrief and discussion.

2. Point out the range of ideas that learners had in the brainstorm for a more sustainable process.

3. Introduce the concept of a **circular economy** or a closed loop.

   • Have learners reflect on the life cycle of a tree in the natural world and how, at the end of its life, it will become energy for plants and animals. Note how this is different from products in a linear economy, which might be burned or placed in a landfill.

   • See the **Circular Economy section of the Background Information** for more resource. Share an example of a circular economy diagram.

   • Point out that a circular economy means more than just recycling. Sustainability needs to be considered at each phase of the process and built into the way that materials are sourced and products are designed and used.

      – Some circular economy approaches even look at reinventing how people use by products by having them lease them. This makes the company responsible for building long lasting products that won't need much up-keep and repair.

4. In the next session, learners will look at some The Tech for Global Good laureates who are helping disrupt the linear economy and brainstorm their own ideas for developing sustainable solutions.

Circular Economy

Manufacturing
for reuse and long life

Responsibly
Sourcing Materials

Environmentally-Friendly
Packaging and Distribution

Reuse

Extended
Consumption

End of Life

See our **educator guides and videos** for more design challenge facilitation techniques. For this lesson check out:

• Systems Design Challenges   • Facilitating Brainstorming   • Sharing Solutions

Introduce the Challenge *(5 min)*

1. Introduce learners to the Innovation Design Process.

    - Remind learners that in the previous session they examined the linear economy and defined several problems within that system.

    - During this session, they will begin to develop solutions inspired by a circular economy. In the following sessions, they will have a chance to share and get feedback on their ideas.

Session Two	60 min total
Introduce the Challenge	5 min
Real-World Solutions	15 min
Brainstorm: Mash-up	15 min
Creating Solutions	20 min
Debrief and Share	5 min

    - Note that the design process is iterative and that they will revisit phases throughout.

2. Introduce the **Design Challenge Scenario**:

You and your team run a sustainable design firm that develops innovative technology processes for a circular economy. A company has hired you to help them develop a solution that makes one or more stages of a product life cycle more sustainable. You can design the product itself, the way it is manufactured, how materials are sourced, or even the entire system. Your team will use your skills as communicators, researchers, collaborators, and creative problem-solvers to develop an innovative product that benefits people and the planet.

3. Explain the design problem and presentation. Address any questions that learners have.

Design Problem	Develop a solution that fits within a circular economy. Your design should make one or more stages of a product life cycle more sustainable.	
Presentation	Your design team will need to create a presentation to share with the company, including: • The problem your team has identified and addressed. • Your team's solution for this problem. • How it will benefit the company, the consumer, and the planet.	

4. Let teams know that before they begin brainstorming a solution, they will look at some examples of other companies for inspiration.

Real-World Solutions *(15 min)*

1. Introduce The Tech for Global Good videos and let them know each group will be watching several videos from one of the innovators who is designing sustainable solutions. Encourage them to focus especially on The Problem and The Solution. Each video will be about two to three minutes long.

2. Organize the learners into their teams from the previous session. Assign each group a device and one of the laureates.

    - Strawcture Eco

    - Goodr

    - MicroByre

3. Encourage learners to pay attention to:
   - *How does this solution reduce impact on the environment?*
   - *How does this solution fit into a circular economy?*
   - *What else stands out about this solution?*

4. Give teams about ten minutes to watch the videos and discuss what they notice. They can take notes on page 3 in their **Circular Economy Project Guides**.

5. At the end of the time limit, have each team share what they noticed about these solutions.

6. As they share, encourage teams to make connections between the solutions and the mind-map they created in the previous session.

Brainstorm: Transform and Disrupt *(15 min)*

1. Now that teams have had a chance to look at some examples of solutions, it's time for them to begin to develop their own.

2. Before beginning the detailed development of their ideas, it may be useful for teams to do some creative thinking. This activity is designed so that they begin thinking of fun ways to build sustainability into products and systems.

3. Hand out sticky notes and pens/pencils to each team. Review the directions on page 4 in their **Circular Economy Project Guides**.
   - Learners will pick one item from each column and try to think of a solution that uses each of those elements.
     – Redefine the concepts of transform and disrupt, if needed:
       - **Transform**: Using all or part of something for a different purpose.
       - **Disrupt**: Coming up with a completely different way to achieve the same purpose (ideally in a more sustainable way).
   - Demonstrate with one of these examples or make up your own.

Product	Stage of the Life Cycle	Transform or Disrupt?	Solution
Shoe	Manufacturing	Transform	An at-home shoe-making machine: recycles single use plastics again and again to make new shoes.
Pencil	Sourcing materials	Disrupt	Next generation pencil: Graphite is replaced with a dry bio ink that is biodegradable. Instead of a wood the exterior is made of recycled paper.
Can Opener	Consumption	Transform	"Thing Opener:" designed to open multiple types of items. Can replace products like can openers, bottle openers, and wine openers. Even opens thick plastic packages!

4. Set a timer and give learners seven minutes to brainstorm.

    • Encourage them to choose randomly from each column to lead to more innovative ideas.

    • Challenge them to see if they can each come up with at least five ideas.

    • They should write one idea or drawing on each sticky note.

5. At the end of the time limit, have team members share their ideas with each other.

6. Each team can select one or two of their favorite ideas to share with the rest of the class.

    • As they share, encourage teams to articulate how their ideas might benefit a company, a person using the product, or the planet.

Brainstorming Tech Tip

Remind teams that during brainstorming, all contributions are encouraged.

• Think of wild ideas.   • Go for quantity over quality.   • Be creative!

For suggestions on structuring a brainstorm session see PDF and video Tech Tips for Facilitating Brainstorming on our **Explore Design Challenge Learning** webpage.

Creating Solutions *(20 min)*

1. Next, give learners time to choose an idea to focus on for their solution.

    • Teams should review the ideas from their brainstorm and pick or combine ideas to develop for their presentation.

    • Encourage learners to look back at the linear mind-maps they made in the previous session and consider whether there is a specific problem or part of the process they want to focus on.

    • They can also consider the approaches taken by The Tech for Global Good Laureates.

    • Encourage teams to conduct additional research on the topic throughout the entire design process. This can be done using background information and resources you provide or by researching online themselves.

2. Rotate around the room and engage in discussions with teams in order to:

    • Have them articulate the problem they are addressing.

    • Help them move past a sticking point or endless debating by prompting them to make a decision or research more to inform their solution.

    Facilitation Questions include:

    • *What ideas have inspired you so far?*

    • *What do you already know about the life cycle of this product? What ideas have already been tried?*

    • *What challenges will you need to confront in order to help solve this problem?*

    • *What about infrastructure or other challenges?*

Debrief and Share *(5 min)*

1. Have teams share their progress and next steps.
   - This can be as simple as asking them to share one idea from their brainstorming that they are excited about.

Extension: Local Waste

To get ideas for their project, teams contact local businesses and ask them about the waste that they produce.
- *What kinds of things are they throwing away on a regular basis?*
- *Do any of those items have another purpose?*

For example, hair from salons or pet groomers can be used to clean up oil spills (see "**Projects - Hair Mats and Oil Spills**," Matter of Trust website).

✋ **Review Design Process** *(5 min)*

1. Describe the format and process for learner presentations. (Reminder: See **Preparation** for detailed options.)
2. Address any questions regarding:
   • Design product format
   • Presentation process, timing, and tools
   • Audience

Session Three	60 min total
Review Design Process	5 min
Share Solutions and Feedback	20 min
Refine Solutions and Prepare to Present	30 min
Debrief	5 min

3. Let learners know that during this session they will share their initial ideas with another team to receive feedback and then refine their solutions and prepare their presentation. They will present their refined ideas to the audience in the next session.

| Presentation | Your design team will need to create a presentation to share with the company, including:
• The problem your team has identified and addressed.
• Your team's solution for this problem.
• How it will benefit the company, the consumer, and the planet. | |

4. Remind learners of the content of the presentation.
5. Remind them that they are working on a solution that fits into a circular economy so they can make one or more stages of a product life cycle more sustainable. *For example:*

Example	Life Cycle Stage	Sustainable Approach
Strawcture Eco	Materials Sourcing	Instead of raw materials, uses waste products that would otherwise be burned
MicroByre	Manufacturing	Uses bacteria to create more eco-friendly factories
Goodr	End of Life	Diverts surplus food that would otherwise be thrown out
Closed Loop	All	No waste is generated, everything is fed back into the system to create something new
Product leasing	All	Manufacturers are responsible for maintaining, repairing, and replacing the product for the time of the agreed lease. Can be applied to phones, cars, or even carpet tiles.

💬 **Share Solutions and Feedback** *(20 min)*

1. Share the process for the **Listen and Help Feedback Protocol.** (See pages 6 in the **Project Guide**.)
   • Explain that the goal for this activity is to get thoughtful and critical feedback from friends.
   • Encourage learners to focus on both strengths and next steps in their feedback. If using simple sentence frames, introduce them at this time. For example: "I like…" or "I wonder…"

2. Ask students to get back into their teams. Then have them pair up with another team.

   • Assign one team each pair to present first. The other team in the pair will be the audience, listening and providing feedback.

3. Act as timekeeper for the class. After the first team has presented, teams should change roles and repeat the process.

4. After the Listen and Help Feedback Protocol is finished, have learners transition into refining their solutions.

> **Tip:** See The Tech's Peer Feedback Protocol on the **Explore Design Challenge Learning webpage** for more Tech Tips on facilitating processes like this, including assessment.

Refine Solutions and Prepare to Present *(30 min)*

1. Give learners time to iterate their solutions. They should reflect on the feedback and think about how it affects their presentations.

2. Support teams in developing presentation materials, planning, and practicing their presentations.

   • Set expectations that all team members will participate in the presentation.

   • As they prepare their presentations, encourage learners to think about how they can both show their ideas and tell about them.

   Facilitation Questions include:

   • *What did you learn from the listen and help protocol?*

   • *How could you improve your solution based on the feedback you received?*

   • *How will your solution help the company, people, and the environment?*

   • *What are some other ways you could explain or show that idea?*

> **More Real-World Examples**
> Encourage teams to research and look for background information as needed to refine their solutions.
>
> • "**Circular Economy Examples and Case Studies**," Ellen MacArthur Foundation website
>
> • "**Case Studies**," MBDC website
>
> • "**Students - Circular Classroom**," Circular Classroom website

Debrief *(5 min)*

1. Check in with teams in preparation for the presentations in the next session.

   • Address any questions learners have and review expectations for the presentations themselves.

Set the Stage *(5 min)*

1. Make sure learners have set up their presentations and have the resources they need to share their ideas.

2. Take a few minutes to review with learners the process for giving presentations.

3. Review the audience's role. If there are new audience members, introduce the teams and the overall challenge.

Session Four	60 min total
Set the Stage	5 min
Present	45 min
Debrief	10 min

4. Review the positive feedback process and tools the audience will use during the presentations.

   For example:
   - If the audience and learners are rotating to see team posters, have them record feedback on sticky notes or notecards.
   - If learners are giving a formal presentation, encourage a few individuals to share one thing they liked and a suggestion for improvement after each team presents.
   - Share suggested prompts for appropriately responding to suggestions and criticism, such as asking for clarity if needed or simply saying, "*Thank you, we will consider that.*"

Present *(45 min)*

1. Have teams present their solutions.

2. Keep track of time to ensure that all teams have a chance to present and receive feedback.

3. If time allows, have teams respond to additional questions.

4. In addition to any questions generated by the audience, you may want to provide a list of **Suggested Questions**:
   - *What inspired you to develop this idea?*
   - *Why did you choose this particular solution?*
   - *What questions did you have as you worked on this project? What do you still want to learn about this problem?*
   - *What is one thing you changed about your idea as you worked on it?*
   - *What is something you would change or want to improve if you had more time?*

> **Tip:** Have learners share their solutions, photos, and videos with The Tech Interactive, #TheTechforGlobalGood.

Debrief *(5 min)*

1. Celebrate learners' work and reflect on the experience.

2. Debrief the project as a class. Discuss what learners saw and learned from the process and each other's work.

3. Debrief Questions can include:
   - *How did your understanding of the way we make and use things change throughout this project?*
   - *What did you learn about sustainability?*
   - *What part of the process was surprising? What barriers did you find?*
   - *What would you change about your solution?*
   - *How did this make you think about how you can impact the world?*

Standards Connections
Next Generation Science Standards

* Indicates science content integrated with engineering.

Grades	Standard	Description
6-8	MS-ESS3-3	Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.*
9-12	HS-LS2-7	Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*
9-12	HS-ETS1-1	Analyze a major global challenge using criteria and constraints that account for societal needs and wants.
9-12	HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
Additional Standards		MS-LS2-5, HS-ESS3-4, HS-ETS1-3, HS-LS4-6

Common Core State Standards: English Language Arts

Grades	Standard	Description
7-10	CCSS.ELA-LITERACY.SL.[grade].1	[Initiate Grade 9-10] Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on [grade] topics, texts, and issues, building on others' ideas and expressing their own clearly [and persuasively Grade 9-10].
7-8	CCSS.ELA-LITERACY.SL.[grade].4	Present claims and findings, emphasizing salient points in a focused, coherent manner: – [with pertinent descriptions, facts, details, and examples Grade 7] – [with relevant evidence, sound valid reasoning, and well-chosen details Grade 8] Use appropriate eye contact, adequate volume, and clear pronunciation.
9-10	CCSS.ELA-LITERACY.SL.9-10.4	Present information, findings, and supporting evidence clearly, concisely, and logically such that listeners can follow the line of reasoning and the organization, development, substance, and style are appropriate to purpose, audience, and task.

California History – Social Science Framework

This activity could be set in a historical context to meet more relevant standards at lower grade levels.
For example: learners investigate a Roman technology to see where there could be opportunities for sustainability.

Grades	Standard	Description
10	10.11	Learners analyze the integration of countries into the world economy and the information, technological, and communications revolutions (e.g., television, satellites, computers).
12	12.2	Learners analyze the elements of America's market economy in a global setting.

Vocabulary

- **Circular economy:** Sustainability is planned into product development from the very beginning and considered at each stage of the process so that rather than following a straight line, there is circularity to the life cycle of a product.
- **Consumer:** One who uses economic goods.
- **Consumption:** The use of something.
- **Distribution:** The process of delivering items.
- **End of life:** The time at which a product is no longer functional or usable.
- **Linear economy:** The traditional production process represented by a straight line: natural resources are extracted from the environment, manufactured, consumed, and then disposed of at the end of their life.
- **Manufacturing:** The process of making or producing something.
- **Packaging:** The process of packing and enclosing items.
- **Sourcing materials:** The process of getting materials for use in manufacturing. This may include raw natural materials as well as recycled or used materials.
- **Sustainable:** Able to be maintained or supported over time. Natural resources, for example, would be used in a way that doesn't entirely deplete them or make them run out.