



The Decarbonization Puzzle

OBJECTIVES

Students will:

- Define decarbonization.
- Understand current decarbonization efforts.
- Investigate why decarbonization is important.
- Explore ways to achieve decarbonization.

OVERVIEW

Students will learn about decarbonization and how different industries/businesses, including Trane Technologies, are working on solutions to lower emissions by decarbonizing. They will participate in a group-based jigsaw activity focused on the reasons decarbonization is needed and ways to accomplish it. They will finish by considering whether decarbonization is an effort that can be taken on by individuals and families.

TIMING

45–60 minutes.

MATERIALS NEEDED

- Pencils, one per student
- Devices with internet access, one per group
- **Decarbonization Puzzle** student handout, one per student

VOLUNTEER PREP

1. Read through the activity instructions to familiarize yourself with the content. Note that approximate times are provided for each section as a recommendation, but each situation will be unique.

Use the Lesson At-a-Glance below to determine how long you plan to spend on each section.

2. Prior to your session, coordinate with your host educator regarding available space and the ideal method to divide students into groups of 3–4 students. This may include moving desks into groups before the start of the session.
3. Prior to your session, familiarize yourself with the [jigsaw](#) teaching strategy, so you are comfortable facilitating it during your session.

4. Prepare all materials before your session.
 - **Note:** Have all puzzle pieces for the **Decarbonization Puzzle** assigned before your session, and organized into groups to facilitate a smooth transition when distributing.
5. Have the **Essential Question** written largely on the board before students arrive.

LESSON AT-A-GLANCE

Section	Activity	Approximate Time in a 45-minute Session	Approximate Time in a 60-minute Session
Engage	Volunteer introductions and Essential Question	6–8 minutes	6–8 minutes
Learn	Decarbonization	7–10 minutes	9–14 minutes
Challenge	Decarbonization Puzzle	20–25 minutes	25–30 minutes
Discuss	Individual decarbonization	5 minutes	5–7 minutes
Closing	Call to action	2–3 minutes	3–5 minutes

PROCEDURE

Engage

1. Take **2–3 minutes** to introduce yourself to the class. Explain that you are here on behalf of Trane Technologies and you are excited to help teach them about sustainability. Briefly explain your role at Trane Technologies and why Trane Technologies is considered a global climate innovator.
2. For approximately **4–5 minutes**, engage students in the upcoming lesson by asking the following **Essential Question**. This question is intended to get students thinking about their upcoming learning experience and does not have a right or wrong answer.
 - What can we do to decrease human impact on the environment?

Learn

3. Tell students that one thing that decreases negative impact on the environment, as well as the topic of today's session, is *decarbonization*. You may want to write this word on the board for reference.
4. Explain to students that decarbonization is the reduction or removal of carbon. What it means with regards to sustainability is, for example, when a company uses energy that produces

low or no levels of greenhouse gasses, also known as CO₂ or Carbon Dioxide, so that it never enters the Earth's atmosphere. This can be accomplished by completely moving to new forms of energy or using carbon capture technology to remove the CO₂ that has already been released.

5. Acknowledge that decarbonization can be a difficult and expensive endeavor for companies. One example might be installing solar panels on the roof of a factory. To undertake decarbonization, a company must decarbonize their power grid and their supply chain as well as capture all existing greenhouse gas emissions. As you share these connections, you may need to help define or provide examples of what it would look like in action.

Note: Students will most likely be unfamiliar with the term "supply chain." Explain to students that a supply chain is a network of people, companies, and actions that help get a product from its raw materials through every step until it gets to the consumer or end user. A useful video for explaining supply chain is [I, Pencil](#).

6. Inform students that while decarbonization is an initiative often taken on by companies and industries, it is possible for individuals and families to make changes to help the decarbonization effort. Companies like Trane Technologies provide opportunities for consumers to decrease their energy intensity by changing or adapting how they use certain products or appliances. Examples include electric hot water heaters, electric space heating, and considering renewable energy sources. This is also an opportunity to have students share examples they have heard of.

Challenge

7. Divide students into groups of four. Based on the prior coordination with your host educator and space provided, have students grouped into desks of four or sitting in circles on the floor. Inform students that this group is their "home group."
 - **Note:** The number of groups will be determined by the size of the class. For example, if you have a class of 24 students, you will have six groups. Count students off into groups based on class size. Go through the class and count 1–6 until all students have a number. Send students to the designated area for each group number. Adjust based on total number of students or if the educator has groups already established.
8. Inform students that they will be participating in a [Jigsaw Activity](#), and pass out a **Decarbonization Puzzle** handout to each student. Make sure that each student in the group receives a different assigned puzzle piece. The puzzle pieces are: 1) Decarbonizing While Building, 2) Benefits of Decarbonization, 3) Carbon Capturing, and 4) Hybrid Heating.
9. Ask a volunteer to read the directions aloud or read them to the class yourself.
10. Assign each puzzle piece a place in the room to meet with the other students who have the same assigned piece. Give each puzzle piece group a device with internet access, and instruct them to begin their research and record their learning on the appropriate page of the handout.

11. After approximately 10 minutes, instruct students to return to their home groups.
12. In order, each puzzle piece “expert” should explain what they learned to their home group, while the other group members take notes on the appropriate page of the handout. Groups should continue until all experts have time to share. When they are done, each student should have a completed packet. As students share, remind each group member to listen carefully, and be sure to ask clarifying questions to the person sharing information.

Discuss

13. Facilitate a brief discussion that gives students the opportunity to respond to the following question. This is an open-ended question meant to give students the opportunity to apply what they have learned. There are no right or wrong answers.
 - Based on what you’ve discovered during your research, do you believe that individuals and families can contribute to the decarbonization effort, or do you believe it to be mostly the responsibility of companies and industries?

Closing

14. Before you leave, thank the classroom teacher and students for allowing you to join them, and encourage them to apply what they have learned about this aspect of sustainability by discussing it with their families. Suggest they share their research on decarbonization and reflect on the class’s discussion question as a family.

EXTENSION IDEAS FOR EDUCATORS

- Conduct a building audit of the school and make recommendations on aspects that could be changed to help decarbonization efforts.
- Research how different industries and companies, including Trane Technologies, work towards decarbonization.

NATIONAL CONTENT STANDARDS

Next Generation Science Standards

- MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.
- MS-ESS3-5: Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Common Core State Standards for English Language Arts

Speaking and Listening

- CCSS.ELA-LITERACY.CCRA.SL.1 Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively.
- CCSS.ELA-LITERACY.CCRA.SL.2 Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally.
- CCSS.ELA-LITERACY.CCRA.SL.6 Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.

Science and Engineering Practices

- Asking Questions and Defining Problems

SOURCES

- <https://terrapass.com/blog/decarbonization-101-what-it-is>
- <https://news.climate.columbia.edu/2018/11/27/carbon-dioxide-removal-climate-change/>
- <https://www.trane.com/residential/en/resources/glossary/dual-fuel-heat-pump/#:~:text=This%20hybrid%20heating%20and%20cooling,and%20money%20on%20utility%20bills>
- <https://www.elevatenp.org/climate/building-decarbonization-is-essential-heres-how-it-works/#:~:text=Climate%20Action-,Burning%20fossil%20fuels%20like%20gas%20or%20oil%20to%20provide%20heating,goals%20to%20mitigate%20climate%20change>
- <https://www.anthropocenemagazine.org/2021/11/climate-action-pays-for-itself-sooner-than-you-think/>
- <https://www.pollutionsolutions-online.com/news/air-clean-up/16/breaking-news/why-is-decarbonisation-important/57635>
- <https://youtu.be/IYO3tOqDISE>

Directions: When instructed, you'll meet with all other students who share your assigned puzzle piece. Record information as you become an expert. Then, return to your home group to share out what you've learned and take notes on the other puzzle pieces.

Assigned puzzle piece:

WHY IS DECARBONIZATION IMPORTANT?

Puzzle Piece #1: Decarbonizing While Building

Visit the following website: <https://bit.ly/3biS3UQ>

Explain how building decarbonization works:

Explain why building decarbonization is beneficial:

WHY IS DECARBONIZATION IMPORTANT?

Puzzle Piece #2: Benefits of Decarbonization

Visit the following website: <https://bit.ly/3QOsFH4> and <https://bit.ly/3tSDP3r>

Explain in detail three benefits of decarbonization:

BENEFIT #1: _____

BENEFIT #2: _____

BENEFIT #3: _____

HOW CAN DECARBONIZATION BE ACHIEVED?

Puzzle Piece #3: Carbon Capturing

Visit the following website: <https://bit.ly/3QDg9Ks>

Explain in detail two ways to achieve carbon capturing:

METHOD 1: _____

METHOD 2: _____

HOW CAN DECARBONIZATION BE ACHIEVED?

Puzzle Piece #4: Hybrid Heating

Visit the following website: <https://bit.ly/3bk6IPB>

Explain how a dual fuel heat pump works:

How does hybrid heating help the decarbonization effort?