Today I Learned About Carbon Capture

Description:

Carbon capture and storage (CCS) and carbon capture and utilization (CCU) are growing technologies. In a hands-on chemistry lab, students can produce a key ingredient in low-carbon concrete. Through reading, discussion, and data exploration, students investigate the future and potential for CCS as one tool in our toolbox to slow climate change.

Skills & Objectives

SWBAT

- Explain the basic concept of carbon capture and storage.
- Explain why it is important to reduce carbon emissions.
- Understand that no one technology will solve all the problems of climate change.

Skills

- Handling of simple chemicals
- Reading and communication
- Map-reading

Students Should Already Know That

- Carbon dioxide in the atmosphere acts like a blanket, trapping heat from the sun. A regular amount of carbon dioxide is necessary for life. As we burn fossil fuels like coal, oil, and natural gas, we release excess carbon dioxide into the atmosphere, trapping excessive heat. This trapped heat is warming our ocean, land, and air. This heat is changing weather and climate patterns all over the world, leading to impacts such as extreme weather.

Standards Alignment:
HS-ETS1-3 Evaluate a solution to a complex real-world problem.
HS-PS1-2 Construct and revise an explanation for the outcome of a simple chemical reaction.
HS-PS2-6 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
CCSS.ELA-LITERACY.RI Reading Informational Text
CCSS.ELA-LITERACY.RST Science & Technical Subjects

Disciplinary Core Ideas:
ESS3.A Natural Resources
ESS3.C Human Impacts on Earth Systems
ESS3.D Global Climate Change
ETS1.A Defining and Delimiting an Engineering Problem

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How To Use These Activities:

Pages with the circular "TILclimate Guide for Educators" logo and the dark band across the top are intended for educators. Simpler pages without the dark band across the top are meant for students.

Each of the included activities is designed to be used as a standalone, in sequence, or integrated within other curriculum needs. A detailed table of contents, on the next page, explains what students will do in each activity.

A Note About Printing

All student pages are designed to be printable in grayscale.

The worksheets do not leave space for students to answer questions. Students may answer these questions in whatever form is the norm for your classroom – a notebook, online form, or something else. This allows you, the teacher, to define what you consider a complete answer.

Podcasts in the Classroom: Throughout these Guides for Educators, we invite students to think about how they would share their learning with family and friends. One way to do this is to encourage your students to create their own podcasts - they're shareable, creative, and have multiple options for embedded assessment. We would love to hear any podcasts or see any other projects you or your students create! Email us at tilclimate@mit.edu, Tweet us @tilclimate, or tag us on Facebook @climateMIT.

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Detailed Table of Contents

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Concrete Without Quarries: A Biomimicry Lesson Plan

Carbon capture is the process of trapping carbon dioxide at the source, such as flue gas from a power plant. Once captured, this carbon dioxide can be stored (usually injected deep underground) or utilized to make other products. This lesson demonstrates one possible utilization for captured carbon dioxide.

The introductory activity for this Educator Guide is a chemistry lesson from The Biomimicry Institute. The full lesson is available in English and Spanish with versions for High School, Middle School, Upper Elementary, and Home School.

https://asknature.org/resource/concrete-without-quarries/

To help you evaluate whether this lesson is a good fit for your class, the description and materials for the High School version are included here.

Lesson Plan Goals and Objectives

1. Conventional manufacturing methods used by humans generally start with the extraction of raw materials from the environment, using processes that result in some degree of environmental damage. These processes over time have resulted in largescale damage to the earth's living systems and, given the earth's inherent limits, cannot continue indefinitely.
2. Harm to the environment is not a necessary consequence of raw material extraction; the prevailing manufacturing model on Earth, practiced by millions of species, is actually one in which raw materials are acquired benignly.
3. By emulating manufacturing processes widespread in the rest of the natural world, humans can transform their production methods to be more benign, and even beneficial to the environment of which humans are a part.

Grade Level, Duration, and Materials

Grade Level: 10th – 12th
Discipline: Chemistry
Duration: Approximately one to two 50-minute sessions, longer if desired

Materials:

- A source of carbon dioxide, such as dry ice (100% CO_2)
- Seawater or a seawater analog, (e.g., seawater mix from a pet store.)
- Aquarium bubbler (optional but recommended.)
- A source of sodium hydroxide (NaOH) (e.g., 100% lye drain opener.)
- Glass containers, rubber tubing, and connectors.
- Filter paper.
- Small bag of quick-set cement (e.g., Quikrete.)
- Vinegar (optional.)

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Season 2 Collection

Season 2 of TILclimate from MIT covers a series of interrelated energy subjects. The associated teacher guides are structured for maximum flexibility. Each episode's activities could be done as a whole class or as small-group work while other teams work on other topics and share back in a jigsaw. Some activities also can be enrichment or homework, and many as asynchronous assignments for remote work. Activities of similar length could also be set up as rotating stations, with a group discussion at the end of class.

- Introductory activities are quick (15-25 minutes) and require no internet.
- Dive Deeper activities are longer (30-60 minutes) and require internet access.

The City of the Future overall project is flexible in terms of time, space, and materials. It will be engaging whether students have completed all activities in the collection, or just one. If teams of students have been working on one topic each, the City of the Future process will help them share their learning with the rest of the class.

Carbon Capture

This Educator Guide includes a chemistry lab, readings, discussion, and a map investigation. Educators may pick and choose among the pieces of the Guide, as suits their class needs.

Parts of this Guide may align with the following topics:

- Chemistry: Producing calcium carbonate (cement) from sea water, carbon dioxide, and sodium hydroxide.
- Life/environmental science: Biomimicry solutions. Connections to coral reefs.
- History/social science: Policies to encourage or discourage carbon capture.
- ELA/nonfiction: Reading and understanding complex science topics.

MIT Resources

We recommend the following as resources for your own better understanding of climate change or as depth for student investigations. Specific sections are listed below:

- Climate Science, Risk & Solutions, an interactive introduction to the basics of climate change. https://climateprimer.mit.edu/
  - Chapter 02: The greenhouse effect and us
  - Chapter 05: How much of the CO2 increase is natural?
  - Chapter 10: What can we do?
- MIT Climate Portal Explainers are one-page articles describing a variety of climate topics. https://climate.mit.edu/explainers
  - Concrete
  - Mining and Metals
  - Carbon Pricing
  - Carbon Capture

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Wrap-Up Discussion Questions

- What is carbon capture and storage? How does it work?
- Carbon capture and storage can be one tool to slow climate change. What are some of the other tools in our collective toolkit?
- In what industries could carbon capture and storage be a good technology to reduce carbon emissions? In what industries might it not be the best fit?
- Which of these tools do you think should get the most support and funding in the coming years? Why?
- If you learned that a CCS facility was being planned in your area, would you support it? Why or why not? What factors might change your mind in either direction?
- What other questions do you have? How might you investigate these questions?

Climate Solutions

Climate solutions can be thought of as falling into four categories outlined below. Across all categories, solutions at the community, state or federal level are generally more impactful than individual actions. For example, policies that increase the nuclear, solar and wind mix in the electric grid are generally more effective at reducing climate pollution than asking homeowners to install solar panels. For more on talking about climate change in the classroom, see “How to Use This Guide”.

- **Energy Shift**
  How do decision-makers make the switch from carbon-producing energy to carbon-neutral and carbon-negative energy?
- **Energy Efficiency**
  What products and technologies exist to increase energy efficiency, especially in heating and cooling buildings?
- **Adaptation**
  How can cities and towns adapt to the impacts of climate change?
- **Talk About It**
  Talking about climate change with friends and family can feel overwhelming. What is one thing you have learned that you could share to start a conversation?

TILclimate

Guide for Educators

What solutions are the most exciting in your classes? We would love to hear from you or your students! Images, video, or audio of student projects or questions are always welcome. Email us at tilclimate@mit.edu, Tweet us @tilclimate, or tag us on Facebook @climateMIT.