

Today I Learned About Hydrogen Energy

Description:

Hydrogen has the potential to replace fossil fuels in many sectors of the economy. Students learn about how (and where) hydrogen can be produced from renewable energy, how batteries and fuel cells work, and where hydrogen could replace fossil fuels. They are challenged to explain batteries and fuel cells to another audience.

Skills & Objectives

SWBAT

- Compare and contrast a battery and a fuel cell.
- Describe how hydrogen is generated.
- Understand how and where hydrogen might be able to replace fossil fuels.

Skills

- Comparing and contrasting
- Communication
- Map-reading
- Graph reading

Students Should Already Know That

Substances such as air, methane, and water are made up of molecules that can be split to form other molecules.

Standards Alignment:

HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs.

HS-PS2-6 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.

RST.11-12.9 Synthesize information from a range of sources into a coherent understanding of a process, phenomenon, or concept.

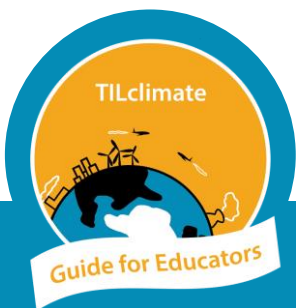
HSS-IC.B.6 Evaluate reports based on data.

Disciplinary Core Ideas:

ESS3.A Natural Resources

ESS3.D Global Climate Change

ETS1.B Developing Possible Solutions



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How To Use These Activities:



Pages with the circular “TILclimate Guide for Educators” logo and 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, except for the maps on pages 2-4 and the diagrams on pages 6+7. A few copies of this page could be printed color for students to share, or the image projected in the classroom.

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.

Answers to Statistics

Fuel	% World CO ₂ Emissions (A)	Mtoe Used by Industry (B)	Total Mtoe (C)	% Used by Industry (C/B)
Coal	44%	726.2	994	73.1%
Oil	34.1%	292	4,051	7.2%
Natural Gas	21.2%	597.9	1,611	37.1%
Total	99.3%	1,616.1	6,656	24.3%

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

Page	Title	Description	Time (min)
	Podcast Episode	Students listen to TILclimate: TIL about hydrogen energy, either as pre-class work at home or in the classroom. https://climate.mit.edu/podcasts/til-about-hydrogen-energy	10-15
1	Green Hydrogen	Students investigate where in the world might be the best locations to pair renewable energy sources with hydrogen fuel generation.	15-20
5	Batteries vs Fuel Cells	Students learn how batteries and fuel cells work, and then are challenged to explain the concept to an audience of their choosing.	20-45+
8	World Energy Use (internet required)	Students investigate worldwide fossil fuel usage and discuss where hydrogen could be used to replace more carbon-intensive energy sources.	20-45+

Water Electrolysis Demonstration

Complete video instructions, safety information, and materials list:
<https://www.exploratorium.edu/snacks/having-gas-with-water>



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Hydrogen Fuel Cells

This Educator Guide includes a map-reading exercise, a communication challenge, and data analysis. 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:

- Physical science: How batteries and fuel cells work.
- Life/environmental science: The impacts of hydrogen vs other fuel sources.
- History/social science: History of batteries and fuel cells.
- ELA/literature: Connections to futuristic literature.
- ELA/nonfiction: Communication about a complex scientific topic.

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

Chapter 10

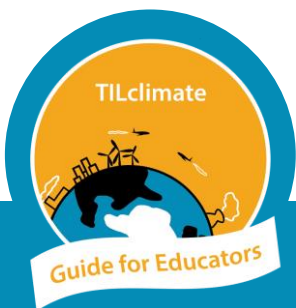
- MIT Climate Portal Explainers are one-page articles describing a variety of climate topics. New Explainers are posted monthly. <https://climate.mit.edu/explainers>

Hydrogen

Energy Storage

Renewable Energy

Greenhouse Gases



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Wrap-Up Discussion Questions

- Where in the world is best suited to using solar or wind power to generate hydrogen fuel?
- How can hydrogen replace other forms of energy?
- What is the difference between a battery and a fuel cell? Where would you use one instead of the other?
- Hydrogen can replace some fossil fuel use by industry. Which fuel would you focus on replacing with hydrogen to have the biggest impact on carbon dioxide emissions?
- What other questions do you have, based on the statistics you saw from the International Energy Agency?

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?

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.

