Today I Learned About Fusion Energy

Description:

Fusion energy has great potential to be an almost-limitless low-carbon energy source. However, scientists haven't yet been able to harness its power. Through a model, a virtual tour, and a research project, students investigate the question – what is the potential of fusion energy, and what part could it play in our future?

Skills & Objectives

SWBAT

- Explain the basics of how fusion creates energy.
- Understand that industries use energy in different ways which have implications for converting to low-carbon energy sources.

Skills

- Research
- Modeling

Students Should Already Know That

- Atoms have a structure that includes subatomic particles such as neutrons, protons, and electrons.
- Most energy sources come from chemical reactions, not breaking subatomic bonds.

Standards Alignment:
HS-PS1-8 Develop models to illustrate the changes in the composition of the nucleus of the atom and the energy released during the processes of fission, fusion, and radioactive decay.
HS-ETS1-3 Evaluate a solution to a complex real-world problem.

Disciplinary Core Ideas:
ESS2.D Weather and Climate
ESS3.C Human Impacts on Earth Systems
ESS3.D Global Climate Change

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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/Materials

All student pages are designed to be printable in grayscale.

The virtual visit to the Alcator facility could be done individually by students on computers or mobile devices or projected on the wall for students to experience as a group. The virtual tour is also available in a format compatible with Google Cardboard. Cardboard is a low-cost virtual reality system that pairs with a smartphone to create immersive experiences. Instructions to purchase ($10-40) or make a Cardboard viewer can be found at https://arvr.google.com/cardboard/get-cardboard/

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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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.

Fusion & Industry

This Educator Guide includes a model, a virtual tour, and a research project. 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: States of matter, stars, atomic interactions
- Life/environmental science: Impacts of energy use on the environment
- History/social science: Decisions about long-term scientific studies

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 09 How long can we wait to act?
  - 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
  - Fusion Energy
  - Concrete
  - Mining and Minerals

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Wrap-Up Discussion Questions

- Why do you think fusion reactions can be sustained in stars but not in labs? What conditions might stars have that are difficult to replicate on Earth?
- In the episode, Professor Whyte talks about the advantage of fusion reactions creating high-quality heat. What are the advantages of an energy source that can provide raw heat, in addition to electricity?
- Not only would a fusion power plant provide high-quality heat, but it would provide it on a massive scale. Imagine a world where fusion is our main energy source. What might our energy, manufacturing, and transportation infrastructure look like? How might it be different from our infrastructure today?
- Fusion has the potential to generate much more energy than our current carbon-free energy technologies, but we don't know when it will work on a commercial scale. Do you think we should count on fusion shaping our energy markets, or invest now in other carbon-free energy infrastructure?

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.