Refrigerants and Climate Change: Don't throw away your refrigerator

Description:

Refrigeration and cooling make food safer, people more comfortable, and protect us in heat waves. The chemicals used to power cooling can be extremely powerful greenhouse gases, adding to climate change. Students investigate the Montreal Protocol, CFC and HCFC replacement, summer heat patterns, and the physics of infrared energy. Then, they investigate two real-world questions in their local community.

Skills & Objectives

SWBAT

- Summarize the goals of the Montreal Protocol and its Amendments
- Concisely explain why CFCs have been replaced with other compounds
- Understand why refrigerants contribute to climate change
- Explain the relationship between warmer summers and increased use of refrigerants
- Investigate real-world questions in their local community

Skills

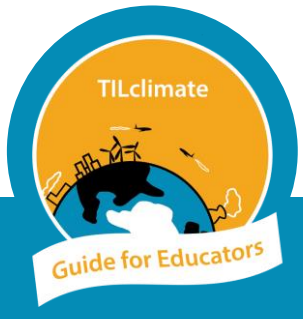
- Reading formal texts
- Science communication
- Graph reading
- Map reading
- Real-world investigation

Students Should Already Know That

The basics of the action of carbon dioxide and other gases as heat-trapping greenhouse gases.

Standards Alignment:
HS-ESS2-4 Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.
HS-ETS1-3 Evaluate a solution to a complex real-world problem.
HS-PS2-6 Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
RST.9-12.2 Determine the central ideas or conclusions of a text
RST.11-12.9 Synthesize information from a range of sources into a coherent understanding of a process, phenomenon, or concept.

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



Refrigerants and Climate Change

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 graph and map on page 5. A few copies of this page could be printed color for students to share, or the image projected in the classroom. Larger versions of this graph and map are provided on pages 6 and 7.

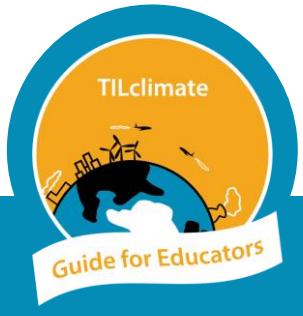
For the Montreal Protocol activity, students could read the article online or the teacher may print copies ahead of time.

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.

A Note About Timing

The first four activities all take about the same amount of time – less than a class period, allowing for an introduction and discussion. These four activities could be done as stations across multiple class sessions, or as a jigsaw with small groups each only doing one activity and sharing their learning with the rest of the class.

Share with us! 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.



Refrigerants and Climate Change

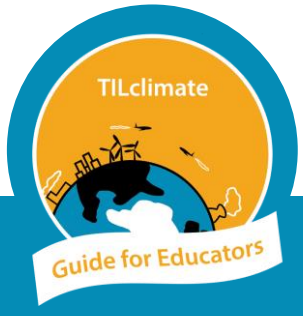
Detailed Table of Contents

A Note About Real-World Investigations

The final two activities in this Guide require that students venture into the community to ask questions and investigate. For the disposal question, they may need to call or email city officials and businesses. For the supermarket investigation, they will need to take a geotagged photo of the refrigeration case and email it to an organization.

Depending on school rules, parental comfort, and student access to the necessary technology, these activities may not be appropriate for all situations.

Consider carefully whether your students have the technology, support, and know-how to ask these kinds of questions safely.



Refrigerants and Climate Change

Refrigeration and Refrigerants

This Educator Guide includes a reading, multiple data explorations, and two real-world investigations. 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: Atmospheric chemistry, infrared energy, and chemical breakdown.
- Life/environmental science: Effects of ozone deterioration and climate change.
- History/social science: The Montreal Protocol and its Amendments.
- ELA/nonfiction: Reading and understanding legal and scientific texts.
- ELA/fiction: Futuristic fiction dealing with climate change.

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
  - Heating and Cooling
  - Extreme Heat
  - Urban Heat Islands
  - Greenhouse Gases
  - Radiative Forcing

- MIT professors can answer your and your students' questions about climate change! Submit your questions or see other answers at https://climate.mit.edu/ask-mit-climate

Refrigerants and Climate Change

Wrap-Up Discussion Questions

- What are some successes of the Montreal Protocol and its amendments?
- What predictions do you make about the use of refrigeration and air conditioning around the world over the next few decades?
- Why are synthetic refrigerants such strong greenhouse gases?
- What surprised you when you investigated how refrigerants are disposed of?
- What surprised you when you visited your supermarket?

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.