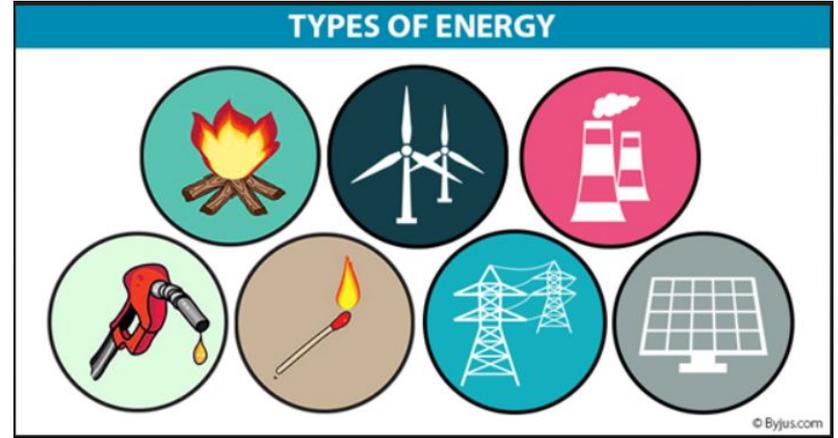


Energy baMEL



Middle Grades Standards

Middle Grades: STEELS

ESS3-MS-03: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Middle Grades: NGSS

MS-ESS3-1: Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

High School Standards

High School: STEELS

ESS3-HS-01: Construct an explanation based on evidence for how the availability of natural resources has influenced human activity.

ESS3-HS-02: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

ESS3-HS-04: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

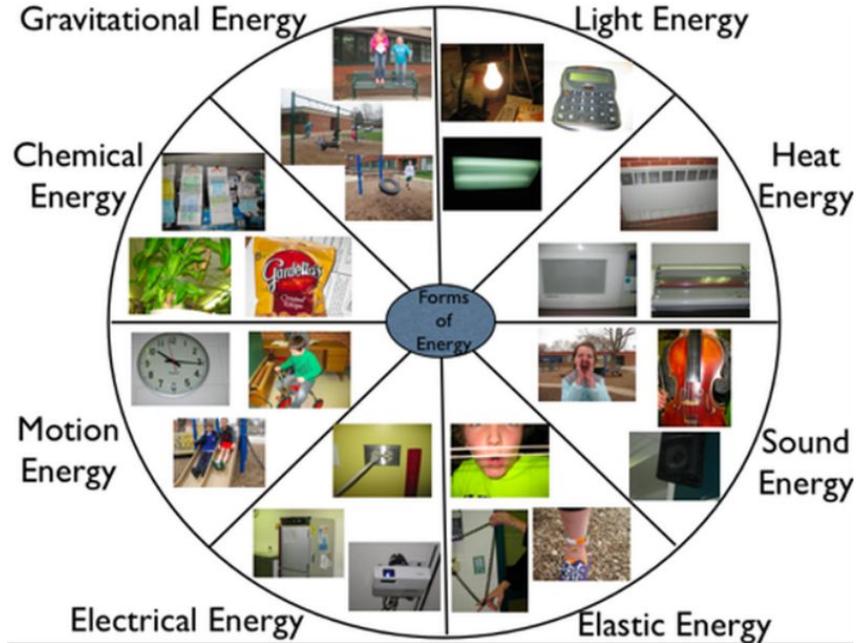
High School: NGSS

HS-ESS3-1: Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity.

HS-ESS3-2: Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

HS-ESS3-4: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

What is energy?



- The capacity or ability to do work or heat objects.
- Energy can be neither created or destroyed but only changed from one way to another.
- The quantitative property of a physical system recognizable in the performance of work and in the form of heat and light.
- There are many forms of energy. We will focus on electrical, heat, light, and motion energy.

Accuracy-Driven Reasoning - How important is this to you or your community?

Burning fossil fuels is not important to me <i>and</i> is not important to my community.	Burning fossil fuels is not important to me, <i>but</i> is important to my community.
Burning fossil fuels is important to me, <i>but</i> is not important to my community.	Burning fossil fuels is important to me <i>and</i> is important to my community.

Model Plausibility Rating

Model A

Burning fossil fuels impacts Earth systems. Other energy sources may help reduce adverse impacts over time.

Model B

Burning fossil fuels is cheap and reliable. The benefits of fossil fuel use outweigh any impacts on Earth systems.

Model C

The impact of burning fossil fuels can be offset by carbon storage. Use of carbon storage systems will allow current levels of fossil fuel into the future.

Pick two models you want to work with!

Model A

Burning fossil fuels impacts Earth systems. Other energy sources may help reduce adverse impacts over time.

Model B

Burning fossil fuels is cheap and reliable. The benefits of fossil fuel use outweigh any impacts on Earth systems.

Model C

The impact of burning fossil fuels can be offset by carbon storage. Use of carbon storage systems will allow current levels of fossil fuel into the future.

Make sure you reach a consensus!

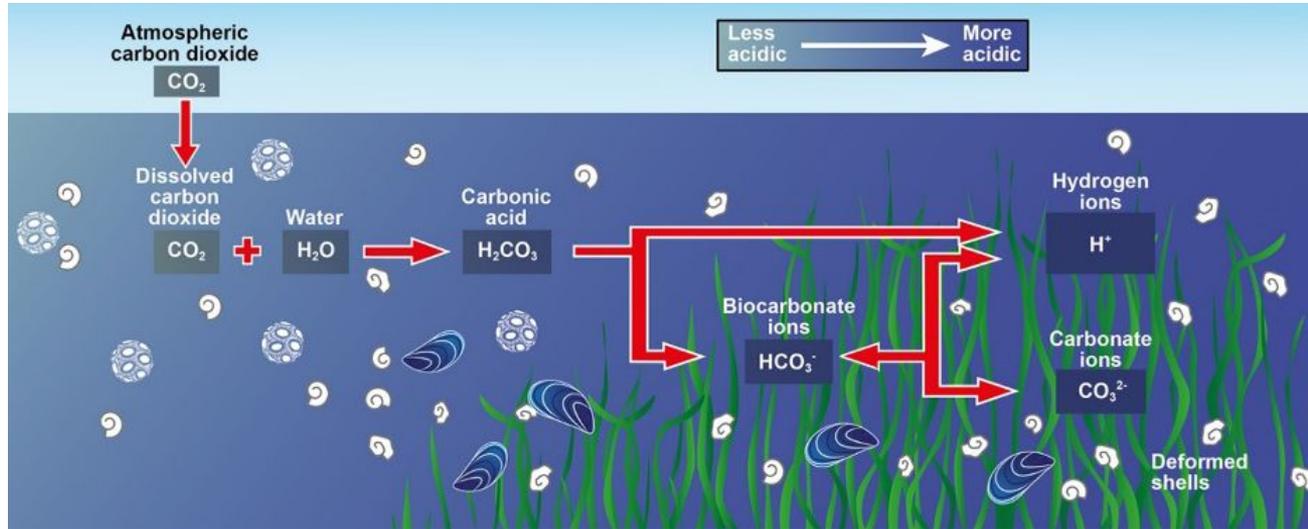
Read the evidence texts and pick four to work with!

<p>EG-Evidence #1 Ocean acidity increases as carbon released into the atmosphere increases.</p>	<p>EG-Evidence #5 Nuclear energy has reliably provided about 20% of U.S. electricity needs since 1990.</p>
<p>EG-Evidence #2 Carbon capture and storage traps carbon emissions from human activities. Carbon capture prevents carbon from being emitted into the air.</p>	<p>EG-Evidence #6 Hydropower converts potential and kinetic energy from water to electrical energy. During operation, hydropower emits very little carbon.</p>
<p>EG-Evidence #3 Electricity can be used to power cars. The source of electricity determines how much carbon is released to the atmosphere from charging electric cars.</p>	<p>EG-Evidence #7 Most hydrogen fuel is produced from fossil fuels in a process that emits carbon.</p>
<p>EG-Evidence #4 About 29% of the world's electricity came from renewable energy in 2021. Renewable energy sources are replenished by nature and emit little to no greenhouse gases.</p>	<p>EG-Evidence #8 Carbon emissions are related to the source of the energy used.</p>

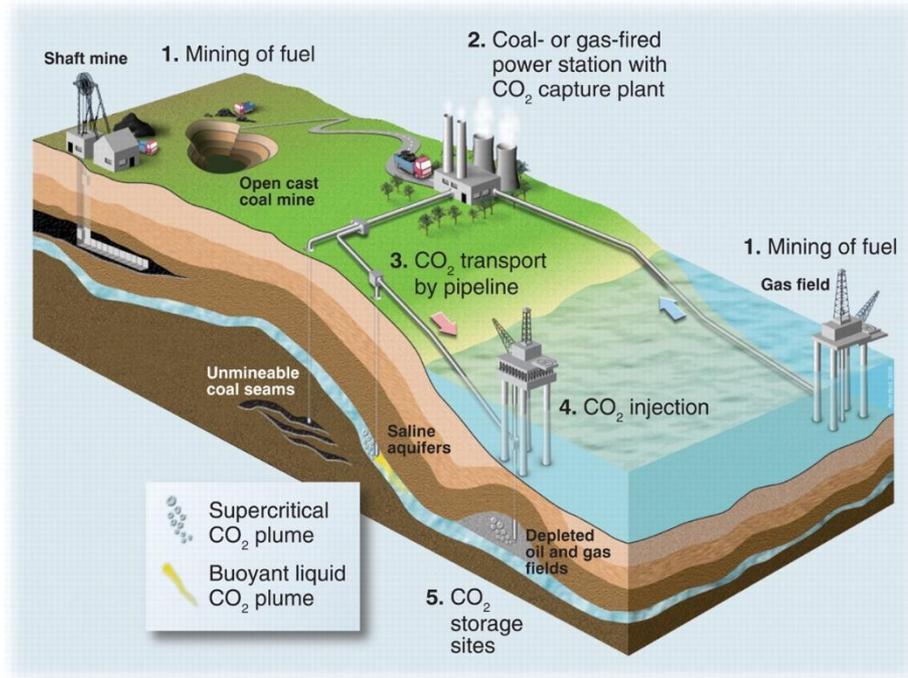
Evidence #1

Ocean acidity increases as carbon released into the atmosphere increases.

- The oceans absorb carbon dioxide which turns into carbonic acid, lowering the pH of the water.



Evidence #2



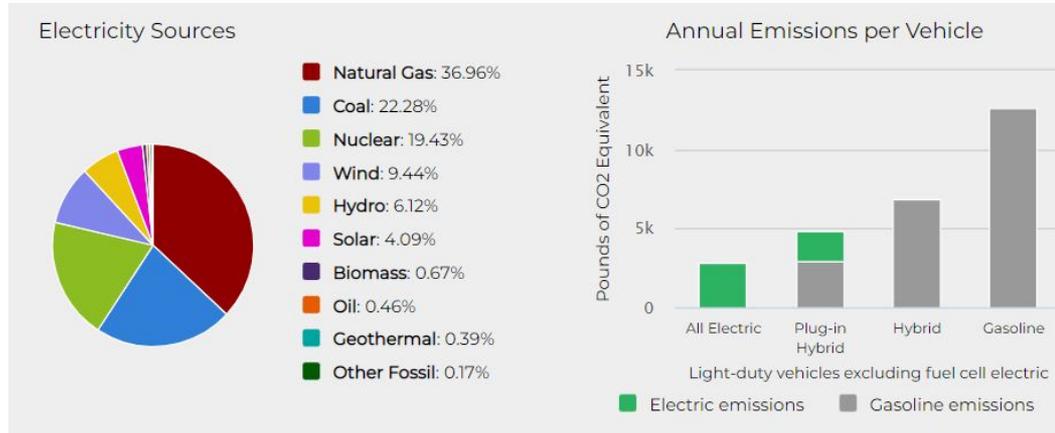
Carbon capture and storage traps carbon emissions from human activities. Carbon capture prevents carbon from being emitted into the air.

- Carbon is injected underground
- Effects?
- Costs?

Evidence #3

Electricity can be used to power cars. The source of electricity determines how much carbon is released to the atmosphere from charging electric cars.

- Emissions from green versus fossil fuel energy generation.



Evidence #4

About 29% of the world's electricity came from renewable energy in 2021. Renewable energy sources are replenished by nature and emit little to no greenhouse gases.

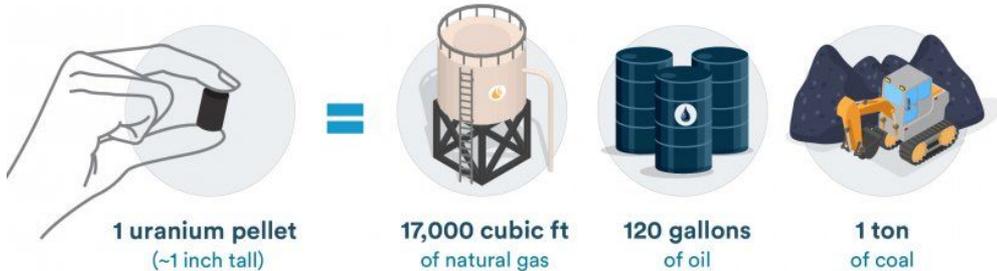
- Wind
- Hydropower
- Biomass
- Solar
- Geothermal



Evidence #5

Fast Facts on NUCLEAR ENERGY

Nuclear fuel is **extremely energy dense.**



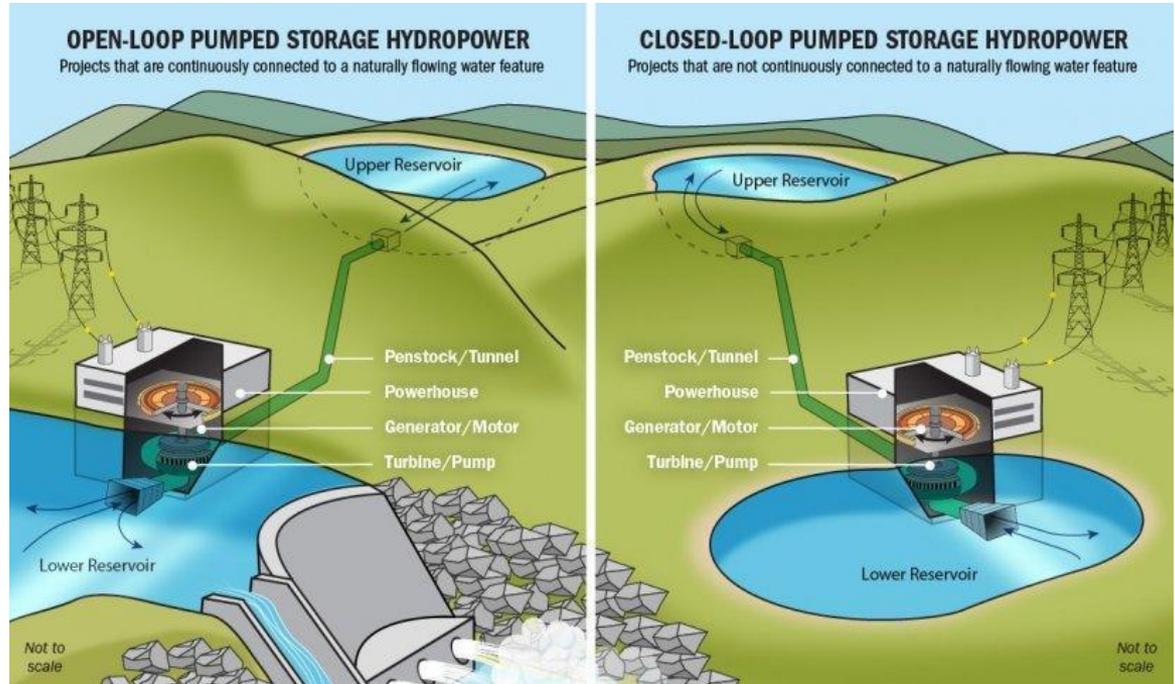
Nuclear energy has reliably provided about 20% of U.S. electricity needs since 1990.

- No carbon dioxide emissions, but it creates radioactive waste.

Evidence #6

Hydropower converts potential and kinetic energy from water to electrical energy. During operation, hydropower emits very little carbon.

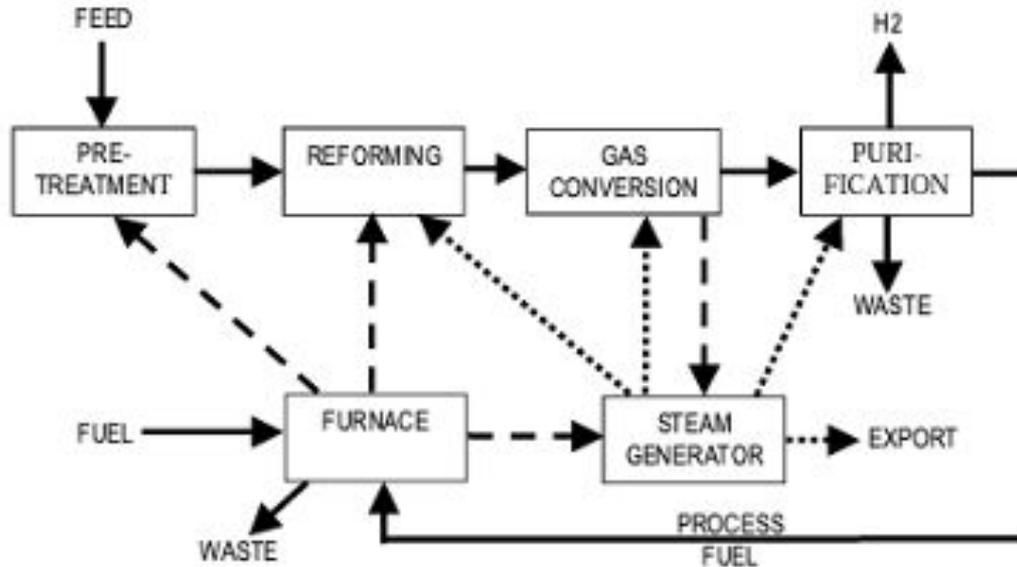
- Battery systems are expensive and have little storage capacity.



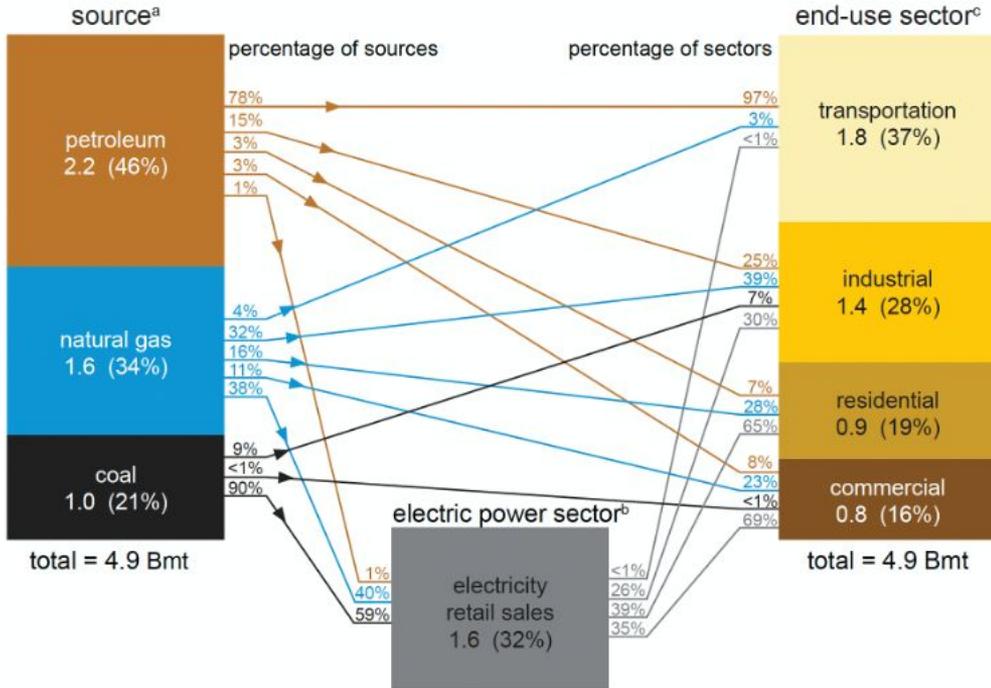
Evidence #7

Most hydrogen fuel is produced from fossil fuels in a process that emits carbon.

- Steam Natural Gas Reforming Process



Evidence #8



Carbon emissions are related to the source of the energy used.

- Almost all electrical energy in the U.S. uses either natural gas or coal, both fossil fuels, as a fuel source.

Read the evidence, discuss the facts with others, and make connections

Draw two arrows from the lines of evidence to the models

Accuracy-Driven Reasoning

Why is it important to accurately evaluate connections between the evidence and models?

1. Before you build and complete your diagram, answer the following questions:

Why is it important to accurately evaluate connections between evidence and models? Check all the boxes that you think apply.

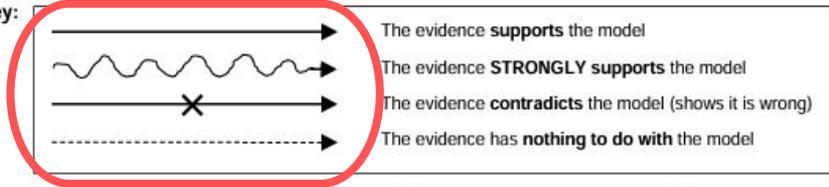
- Accurately evaluating connections helps me check if models are supported by strong, relevant evidence.
- Accurately evaluating connections helps me make sure that models align with popular opinions and trends.
- Accurately evaluating connections helps me make scientific judgments about model truthfulness.
- Accurately evaluating connections helps me identify gaps or inconsistencies in the evidence supporting the model.

Explain why you selected your choices above. What was your reasoning for the selections you chose?

MEL Diagrams

Directions: Write the number of each piece of evidence (#1-8) you are using and each model (A, B, or C) you have selected in the boxes below. Then draw 2 arrows from each evidence box, one to each model. You will draw a total of 8 arrows.

Key:



Evidence # _____

Model _____

Evidence # _____

Evidence # _____

Model _____

Evidence # _____

- Use the two models and the four evidence texts chosen to complete the diagram.
- Draw two arrows from each evidence text to each model.

Explanation Task - Reconsider Plausibility Rating

Please work on this part individually after you complete your diagram.

1. Now that you have completed the diagram, reconsider the plausibility of Models A and B (and C, if there is one). Circle the plausibility of each model. [Make one circle for each model.]

	Greatly implausible (or even impossible)									Highly plausible
Model A	1	2	3	4	5	6	7	8	9	10
Model B	1	2	3	4	5	6	7	8	9	10
Model C (if there is one)	1	2	3	4	5	6	7	8	9	10

2. For the model you selected as most plausible, explain why you think so.

Explanation Task

3. Which arrows changed your plausibility judgments about the models? If your plausibility judgment did not change, which arrows supported your original plausibility judgments? Consider 2 lines of evidence. For each line, does it support, strongly support, or contradict one of the models? Why? When writing your explanation, consider the following:
- Use the specific information from the evidence text and figures to support your response. Ex: when looking at graphs or figures, be sure to describe the patterns in the data.
 - Describe any cause-and-effect relationships found in the text.

Evidence #___ strongly supports | supports | contradicts | has nothing to do with Model_____ because:

Evidence #___ strongly supports | supports | contradicts | has nothing to do with Model_____ because:

Acknowledgements



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