

Solar Schools for British Columbia

A collection of
lessons to assist
teachers and students
with their exploration
of solar energy



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Greenhouse Gas Line-up

Comparing fuel sources and greenhouse gas emissions

What will happen

Students work together to estimate and rank relative greenhouse gas (GHG) emissions for 6 major energy sources. They then compare their results with that of other students and finally use a bar graph to determine the true emission levels of the energy sources.

Students will

- Know what the term 'greenhouse gases' means and how they relates to global warming;
- Know that different energy sources produce different levels of greenhouse gas emissions;
- Understand the relative differences between GHG emission levels from different energy sources;
- Analyze a bar graph depicting GHG emissions from different energy sources;
- Evaluate the best energy sources to use to reduce GHG emissions;
- Know that by using the sun instead of fossil fuels as an energy source, fewer greenhouse gases will be released into the atmosphere.

Total Time	Establish what students know	Activity	Debrief what students learned
45 minutes	10 - 15 minutes	10 - 15 minutes	10 - 15 minutes

What you need to know

When we use energy, we create greenhouse gases. Different fuels create different greenhouse gas (GHG) emission levels.

What might surprise you

- Without the naturally occurring greenhouse effect the average temperature on earth would be -18 degrees Celsius. Source: www.climatechange.gc.ca

What you need

- 6 large energy source cards; one each of oil, natural gas, coal, hydro, solar and wind.
- 2 copies of *Emissions by Energy Source* graph or an overhead transparency of the graph.

Vocabulary

- **Greenhouse Gases** – these absorb infrared radiation in the atmosphere and cause a greenhouse effect. This effect makes temperatures on Earth warmer. Greenhouse gases include water vapour, carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), halogenated fluorocarbons (HCFCs), ozone (O₃), perfluorinated carbons (PFCs), and hydrofluorocarbons (HFCs). Source: EPA
- **Hydropower** – this is the electrical power created from the energy of moving water.



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Establish what students know

1. Ask students what they know about greenhouse gas.
2. Ask students what it feels like in a greenhouse? Can it get too warm? What happens to the plants when it gets hot?
3. Visit the Government of Canada's Climate Change information site www.climatechange.gc.ca and follow the links to *Information on Climate Change* and then to both *The Greenhouse Effect and Climate Change 101*. Work with your students to interpret the information provided regarding the natural greenhouse effect and the enhanced greenhouse effect.
4. Use a diagram, such as the one contained in the backgrounder, to help explain this concept.

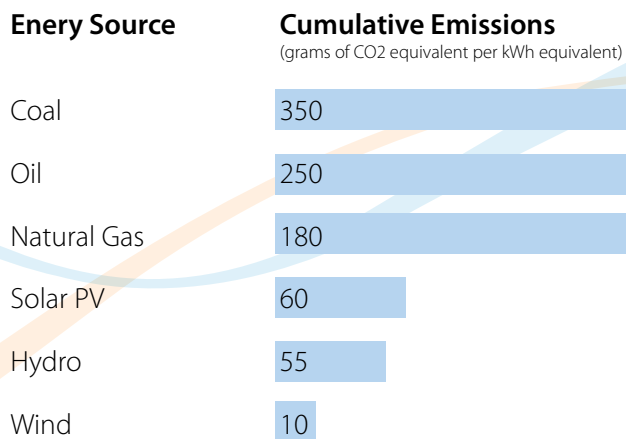
Main Activity

What you do

1. Tell students they are going to work together to estimate and rank relative greenhouse gas (GHG) emissions for the most commonly used energy sources.
2. Choose 6 volunteers and give each person one of the energy cards: oil, coal, natural gas, hydro, wind and solar photovoltaic (solar PV).
3. Discuss the nature of the energy source to ensure students understand what each of them is.
4. Tell the students they are going to work in two teams to sort these energy sources from the most greenhouse gas emission levels to the least.
5. Divide the rest of the class in half, group A and group B.
6. Tell the students that Group A will sort the resources first. Group B will then have an opportunity to change the order if they wish.
7. Ask Group A to decide where they think each volunteer should stand in the side-by-side line-up. Remind them to place the energy source that they think creates the most greenhouse gas emissions on the left and the energy source that creates the lowest levels on the right. Have them sort the ones in the middle along the continuum. Encourage students to discuss the placement and give reasons for their thinking e.g. Highest GHG levels to the lowest GHG levels.
8. When Group A has finished lining up the volunteers in an order they think is correct, ask them why they arranged them this way. Record the results for Group A.
9. Have Group B look at the line up and decide if it is the correct order. They may move the energy sources to different places in the line up if they wish. If they do move any of the sources, have them explain why. Record the results for Group B.

10. When both sets of results have been recorded, provide each group with a copy of the *Emissions by Energy Source* graph.
11. Compare the student results with the bar graph provided.

Emissions by energy source



Source: Organization for Economic Cooperation and Development

Debrief student learning

- Discuss any similarities or differences determined.
- Have the groups summarize what they discovered through this lesson, using questions like:
 - where there any surprises in the line up?
 - how did your group come to your conclusions?
 - how confident were you in your line up placements?
 - where did you get the information that you used to base your decisions on?
 - if more people knew this information do you think it would affect their fuel choices?

Assessment

- Have students explain or diagram how greenhouse gases affect temperatures on Earth.
- Students should be able to accurately describe the distinction between the importance of the natural greenhouse effect and the concerns of the enhanced greenhouse effect.
- Have students record their top three best choices for energy sources that reduce GHG emissions.

Extensions

- In pairs, have students conduct an online search for greenhouse gas cartoons and select one to share with the class. As a large group, have each pair explain why they chose the cartoon they did and how it reflects current thinking on GHG emissions and/or climate change.
- Have students research current innovations solar powered technology such as T.V.s, cars, airplanes, stoves, video games, cell phones, hair dryers, etc. Invite them to share and explain the ones that interest them most.

Check out

Links

- Government of Canada's Action on Climate Change www.climatechange.gc.ca
- Good description of greenhouse gas effect
<http://www.epa.gov/climatechange/kids/greenhouse.html>
- Interesting class game <http://www.wildbc.org/publications-resources/climatechange/greenhouse-gas-game2.pdf>
- Simple matching game - greenhouse gas to source
http://www.ecokids.ca/pub/fun_n_games/printables/puzzles_&_wordgames/assets/environmental/ghg-actsheet.pdf
- Greenhouse Gas Equivalencies Calculator
<http://www.epa.gov/cleanenergy/energy-resources/calculator.html>
- An insight into how solar hot water is taking off in China. Read the article and discover how the current number of solar roofs in China is equivalent to the energy production of 49 coal-fired plants.
<http://www.altdotenergy.com/2010/03/the-prospects-for-solar-thermal-worldwide/>



cosi

110

wind

Hydro

Natural
Coas

Solar PV

EMISSIONS BY ENERGY SOURCE

Energy Source	Cumulative Emissions (grams of CO2 equivalent per kWh equivalent)
Coal	350
Oil	250
Natural Gas	180
Solar PV	60
Hydro	55
Wind	10

Source: Organization for Economic Cooperation and Development

EMISSIONS BY ENERGY SOURCE

Energy Source	Cumulative Emissions (grams of CO2 equivalent per kWh equivalent)
Coal	350
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