Teacher's Guide: Greenhouse Gases Around the World (With Answers)

Print the student version (after this guide). Print the table on a single page so they can have it.

1. Glossary - 5 min

Greenhouse gas – A gas that traps heat in the air and makes the Earth warmer. (Example: Carbon dioxide from cars and factories.)

Greenhouse gas emissions – The total amount of pollution a country releases into the air.

Greenhouse gas emissions per person – The amount of pollution divided by all the people in a country.

Cumulative CO2 emissions - Cumulative CO2 emissions are the running sum of annual emissions since 1750. This measures fossil fuel and industry emissions. Land-use change is not included.

Completed table

Country	Emissions per person (tons)	Total emissions (million tons)	US equivalent
Australia	22	580	0.8
Switzerland	4.5	40	3.8
United States	17.2	5,890	1
Saudi Arabia	24.6	879	0.7
El Salvador	1.7	11	10.1
China	9.8	13,970	1.8
Algeria	6.1	283	2.8
Uganda	1.3	65	13.2
Germany	7.9	671	2.2
India	2.9	4,200	5.9

2. Finding Per Person Emissions - 15 min

(1) El Salvador per person emissions = 0.099 x United States per person emission

El Salvador = 17.2 * 0.099 = 1.7 tons per person

(2) 3.8 citizens from Switzerland emit as much as 1 person in the U.S.

Switzerland = 17.2 / 3.8 = 4.5 tons per person

(3) China would have to reduce its per person emissions by 38% to match Algeria's per person emissions. - *Needs to solve (6) first*

China = 6.1 * 100 / (100-38) = 9.8 tons per person

(4) Australia per person emissions = Saudi Arabia per person emissions - (2 × Uganda per person emissions) - Needs to solve (5) and (8) first.

Australia = 24.6 - 1.3 * 2 = 22 tons per person

(5) Algeria emits 35% more than Switzerland in terms of per person emissions - *Needs to solve (2) first*

Algeria = 4.5 * 1.35 = 6.1 tons per person

(6) India's per person emissions would equal those of El Salvador if El Salvador per person emissions were doubled while India's emissions were increased by 17.2% - *Needs to solve (1) first*

India = (1.7 + 1.7) * 100 / 117.2 = 2.9 tons per person

(7) The average per person emissions of Saudi Arabia, Germany, El Salvador, and Australia are 14.05 tons - *Needs to solve (1), (4), (10) first*

Saudi Arabia = 14.05 * 4 - (7.9 + 1.7 + 22) = 24.6 tons per person

(8) If X's per capita emissions were 2.9 tons, it would be the median of Switzerland and Uganda - *Needs to solve (2) first*

Distance between Switzerland X = 1.6, so Uganda = 2.9 - 1.6 = 1.3 tons per person

(9) Germany's total emissions = India's emissions + 1.11 * Switzerland - *Needs to solve (7) and (2) first*

Germany = 2.9 + 1.11 * 4.5 = 7.9 per person

3. Finding Total Emissions - 15 min

(1) Australia's population is 26,4 million people.

Australia = 26.4 * 22 = 580 million tons

(2) The US's total emissions are a bit more than 10 times those of Australia.

580 * 10 = 5,800 => US = 5,890

(3) El Salvador has the smallest number of total emissions.

El Salvador = 11

(4) Germany's total emissions are 115% of Australia's emissions.

580 * 1.15 = 667 => Germany = 671

(5) The range between Germany's total emissions and Uganda's total emissions is 606.

Uganda = 671 - 606 = 65

(6) Switzerland's total emissions equal 0.0068% of US's total emissions.

Switzerland = 40

(7) Saudi Arabia's total emissions are the closest number to double of Australia's total emissions.

580 * 2 = 1,160 => Saudi Arabia = 879

(8) US's and India's total emissions are 5,045 on average.

India = 2 * 5,045 - 5,890 = 4,200

China = 13,970 (only one left)

4. Comparison to US per person emissions - 10 min

For each country, calculate how many people it would take to emit the same amount as one person in the US. Complete the table.

Australia = 17.2 / 22 = 0.8

Switzerland = 17.2 / 4.5 = 3.8

United States = 1

Saudi Arabia = 17.2 / 24.6 = 0.7

El Salvador = 17.2 / 1.7 = 10.1

China = 17.2 / 9.8 = 1.8

Algeria = 17.2 / 6.1= 2.8

Uganda = 17.2 / 1.3 = 13.2

Germany = 17.2 / 7.9 = 2.2

India = 17.2 / 2.9 = 5.9

5. Cumulative emissions - 15 min

For each country, calculate its cumulative share of global emissions and its share of the global population. The world population is 8,025,000,000.

US's Cumulative Emissions

The U.S. population is 343,477,335. If emissions were evenly distributed, the U.S. population should be 1,912,357,500.

1,912,357,500 * 100 / 8,025,000,000 = 23.83 % (Share of cumulative emissions)

343,477,335 * 100 / 8,025,000,000 = 4.28 % (Share of population)

China's Cumulative Emissions

China's population is 1,422,584,933. Each Chinese citizen has historically emitted 7 times less than an American.

What is China's cumulative share of global emissions? What is its share of the global population?

23.3 / 343,477,355 = 0.00000007 (Average American citizen's share of cumulative emissions)

0.00000007 / 7 = 0.00000001 (Average Chinese citizen's share of cumulative emissions)

0.00000001 X 1,422,584,933 = 14.23 % (Share of cumulative emissions)

1,422,584,933 X 100 / 8,025,000,000 = 17.73 % (Share of population)

El Salvador's Cumulative Emissions

El Salvador's population is 6,309,624. If every country was emitting the same amount of emissions, El Salvador's population would be 8 times higher.

6,309,624 X 100 / 8,025,000,000 =0.08 % (Share of global population)

0.08 / 8 = 0.01 % (Share of cumulative global emissions)

6. Critical Thinking – Who Should Reduce More?

You will find here four possible discussions to reflect on the previous exercises. You can either go through each discussion as a class or have students discuss each topic in smaller groups. Make sure to give them time to report what they have discussed. If time is limited, you can either select one discussion or split the discussions between different groups, ensuring that each topic is still covered without taking too much time.

Discussion 1: Does the U.S. emit more or less than its fair share compared to its population? What about China? What about El Salvador?

The U.S.: Represents 4.28% of the world's population but has emitted 28.83% of cumulative CO_2. Has historically contributed disproportionately to global emissions. The U.S. benefits from industrialization and economic growth fueled by past emissions.

China: Represents 17.73% of the world's population but has emitted 14.23% of cumulative CO_2. Rising emissions due to rapid industrialization, but historical emissions are lower than US Per capita, the average Chinese citizen has emitted far less than an American.

El Salvador: Represents 0.08% of the world's population but has emitted only 0.01% of cumulative CO_2. This highlights the stark difference between developed and developing nations. Despite its minimal contribution, El Salvador still faces climate consequences.

High-emitting nations like the U.S. have a greater historical responsibility. Developing countries have contributed very little but often experience the worst climate impacts. Should emissions reduction policies consider historical emissions?

Discussion 2: What does this tell us about historical emissions and fairness in climate policies? Should countries with historically low emissions be expected to reduce as much as high-emitting countries?

Historical emissions shape today's climate crisis.Countries that industrialized early (U.S., Europe) have contributed most to cumulative emissions. Countries industrializing now (China, India) argue they shouldn't be held to the same standards.

Equity vs. Equal Reduction: Some argue for equal reductions (e.g., all countries cut by 50%). Others argue for equity-based reductions, where high-emitting countries reduce more.

Developing nations' dilemma: They need economic growth but face pressure to curb emissions. Should they have the same reduction targets as wealthier nations?

Debate: Should the U.S. and China be held to the same emissions standards? Why or why not?

Discussion 3: Who should take more responsibility for reducing emissions: countries with high per capita emissions (like the U.S.) or countries with high total emissions (like China)? Why?

High per capita emitters (U.S., Australia, Canada): Fewer people, but each person emits much more. Often wealthier, meaning they can afford climate action. Have benefited the most from fossil fuel use.

High total emitters (China, India): Large populations mean total emissions are high, but per person, they emit far less. Industrialization is recent, so historical emissions are lower. Reducing emissions too quickly could hurt economic development.

Guiding Questions:

- Should wealthier nations provide financial/technological support to developing countries?
- Is it fair to expect China to cut emissions at the same rate as the U.S.?
- How should responsibilities be divided in international climate agreements?

Discussion 4: If global emissions need to be reduced by 50%, how could different countries contribute fairly? Should reductions be based on per capita emissions, total emissions, or historical responsibility?

Per capita approach: Each person gets an equal carbon allowance. Would require the U.S. and Australia to cut emissions drastically.

Total emissions approach: Each country reduces emissions by the same percentage. Easier to enforce but doesn’t account for past emissions.

Historical responsibility approach: Countries that contributed most to past emissions reduce the most. Reflects climate justice but can be harder to negotiate.

Possible Solutions:

- Wealthier nations fund green energy transitions in developing countries.
- Progressive reduction targets: larger cuts for high per capita emitters.
- Incentives for clean energy adoption rather than strict limits.

7. Wrap-up - 5 min

Have your students complete this little activity.

Write 2-3 sentences about what you learned today. How will this information change the way you think about pollution and climate change?

Student's Worksheet: Greenhouse Gases Around the World

Name: ____________________ Date: ____________________

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What is China's cumulative share of global emissions? What is its share of the global population?

Hint: Find the average American citizen's share of cumulative emissions and the average Chinese citizen's share of cumulative emissions

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