CARBON CRUNCH

METHOD

Students use a timeline to explore energy-related environmental issues through history then compare countries based on their CO_2 emissions and their climate vulnerabilities.

INTRODUCTION

Fossil fuels like oil, coal, and natural gas power our automobiles, heat our homes, provide electricity for our appliances, and allow us to live an unprecedented standard of living. But it has not always been this way. Before the Industrial Age, heat was derived from the sun or by the burning of materials, transportation relied on wind-blown sails or horse drawn carts, and machinery was powered with manual labor, water, or wind. With the discovery that fossil fuels could be burned (combusted) to power machines, the energy landscape was transformed and along with it, our atmosphere.

When burned, carbon-based fossil fuels combine with oxygen to form carbon dioxide (CO_2). Carbon dioxide is now the leading greenhouse gas, accounting for over three-quarters of total emissions.[1] Climate change is a direct result of increased carbon in our atmosphere. Research is now showing that to minimize the dangerous impacts of climate change – including the destabilization of the polar ice caps, increases in severe weather, and sea level rise – we must stay within a “carbon budget.” We have already used over half of that budget, and if we stay on our current course, the remainder will be drained in just 30 years.

Parts 1, 2 and 3 are in-class activities. The assessment is an out of class writing assignment.

MATERIALS

- Personal computers/tablets
- Student Worksheet
- Country Cards (provided)
- Snap cubes or LEGOs/Duplos
- Student Reading
- Chart 1: CO_2 and Climate Vulnerability (provided)
- Chart 2: CO_2 and Vulnerability Adjusted for Coping Ability (provided)

CONCEPT

Population growth and industrialization have taken a toll on the global environment. Carbon dioxide emissions are changing the climate, disproportionately affecting the world’s most vulnerable people.

OBJECTIVES

Students will be able to:

- Gather information from a timeline to report on human-environment interactions during a specific time period.
- Interpret visual data to compare carbon dioxide emissions around the world.
- Discuss countries in terms of their per capita carbon use and their risk for experiencing climate change related disasters.
- Explain the “carbon budget” and use evidence to justify if the carbon budget is achievable.

SUBJECTS

Environmental Science (General and AP), World History, AP Human Geography, Geography, Government

SKILLS

Classifying historic events, interpreting and analyzing data, comparing and evaluating data, writing

PART 1

Investigating the Timeline

People have always interacted with the world around them, but over time, those interactions have changed. The Industrial Revolution ushered in new forms of energy and consumption that forever altered people's relationship with the planet.

Procedure:
1. Display www.WorldPopulationHistory.org and point out the environment timeline at the bottom of the screen (the orange bar with the tree icon). If the class is unfamiliar with the site, you can give them a "tour" of the site's components.

2. Ask students to hypothesize how human interactions with the environment have changed over the years. Have these interactions been positive or negative?

3. Divide students into small groups, distribute one Student Worksheet per group, and assign each group one of the following date ranges. *Note: Larger classes will have multiple groups investigating the same portion of the timeline.*

a. 1 C.E. – 1800
b. 1801 – 1968
c. 1969 – 2000
d. 2001 – 2050

4. Each group should complete the Student Worksheet by investigating the environment timeline for their assigned date range.

5. When completed, ask each group to share their summary statement with the class.

PART 2

Carbon Emissions Past and Present

The mechanization of production brought about by the Industrial Revolution resulted in rapidly increasing emissions. In 2011, when world population hit 7 billion, emissions were 150 times higher than they were in 1850 when world population was 1.2 billion.[2] And today, carbon dioxide emissions are at their highest point in all of human history.

Procedure:
1. Display www.WorldPopulationHistory.org and enable the CO_2 Emissions Overlay (select Overlays, click Fossil Fuel CO_2 Emissions). Turn off the Population Dots (select Map Features, click Population Dots and Milestones so they are no longer highlighted blue) to see the colors of the overlay more clearly. Click the "play" button to see an animation of changing carbon dioxide levels from 1751-2010. Discuss the following questions:

a. What year does the first metric ton of CO_2 appear on the map? Where is it located? Why do you think this is the case?

The first bubble representing carbon appears in the United Kingdom in the mid-1850s during the Industrial Revolution. Energy could now be harnessed to power machines and as manufacturing increased, so did carbon use.

b. What happens to the amount of CO_2 as the years go on?

Carbon dioxide increases over time.

c. Where does the first red bubble, indicating 250 metric tons, appear?

In the United States.

2. Now play the CO_2 overlay animation again with the Population Dots turned on (select Map Features, click Population Dots so it is highlighted blue) and discuss the following questions. *Note: Toggling the Population Dots on and off can be helpful when answering these questions.*

a. What do you notice about the relationship between carbon dioxide emissions and population over time?

As global population increases, global emissions also increase. Both population and carbon dioxide emissions grow after the dawn of the Industrial Revolution when advances in medicine, technology, and sanitation lead to longer life expectancy as well as higher demand for energy. An ever-growing and ever-advancing population means continued increases in carbon use.

b. Is energy being used equitably around the globe? Explain.

No. There are several places on the map that have many population dots, but not many CO_2 bubbles. This indicates that the people who live there do not use much energy. South America and Africa are examples of this. Conversely, areas with fewer dots but a significant number of bubbles (especially darker ones) indicate high per capita energy use.

3. Ask students to pair up and give each pair a Country Card. Based on the card's data and using snap cubes (or Legos/Duplos), instruct each pair to create towers representing the amount of per capita CO_2 emissions for their country. Each cube represents 0.5 metric tons of carbon dioxide.

4. Country pairs line up in order from least to most emissions, displaying both their CO_2 stack and their country name for everyone to see. (It is easier for everyone to see if one student in the pair holds the Country Card while the other holds the CO_2 stack and the country pairs form a horseshoe shape rather than a line.)

Discussion Questions:

1. What do you notice about how carbon dioxide emissions are distributed around the world?

Answers will vary, but students should notice there are significant differences in per capita emissions.

2. Point out the different colors of the Country Cards, and ask students to hypothesize what the colors might represent.

Income level/wealth. Explain that the categories follow the World Bank classifications[3] as follows:
green = high-income
blue = upper-middle-income
orange = lower-middle-income
red = low-income

3. Is there a relationship between wealth and per capita carbon dioxide emissions?

Yes, wealthier countries emit more carbon dioxide per capita, indicating that more energy is being used for industrial purposes as well as in people's day-to-day lives.

4. Can we tell from looking at this line-up which country is emitting the most total carbon? Why or why not?

No. While per person measurements provide insight into the lifestyles within a country, they cannot tell us how much CO_2 is emitted in total. To determine total emissions, we would need to know the population of each country. For instance, China emits much less carbon dioxide per person than the U.S., but their population is much larger, making their total CO_2 emissions nearly 8.3 billion tons, the largest in the world.[4]

5. Look at the Population Dots in China and India and consider their per capita emissions. What would happen to the total global emissions if per capita numbers drastically increased in these countries?

There would be a huge impact. Total emissions would increase significantly.

PART 3

The Carbon Budget and Who Stands to Lose

Just as CO_2 is not emitted evenly around the Earth, the climate-related risks faced by different countries also vary significantly.

Procedure:
1. Have students read the Student Reading "The Global Carbon Budget – How Do We Divide the Pie?"

2. Define **climate vulnerability:** the extent to which climate change may damage or harm a system.

Explain that you'll be ranking each country's vulnerability within four areas of climate related risks: Extreme Weather, Sea Level Rise, Agricultural Productivity Loss, and Overall Risk (Overall Risk accounts for all three categories). Be sure students understand that the numbers on the back of their cards indicate their rank in comparison to other countries. For example, a number 8 would mean that country is the 8th most at risk for that particular issue.

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3. Instruct the country pairs to stand up if they are ranked within the top 80 countries in terms of vulnerability to Exteme Weather (pairs should stand if they're ranked between 1 and 80). Be sure each pair stands so the whole class can see the front of their card and their CO_2 stack. Have students observe which countries are standing.

4. Repeat this procedure, having students stand if they're ranked in the top 80 countries for each category – Sea Level Rise, Agricultural Productivity Loss, Overall Risk. *Note: If you'd like to shorten this activity, simply skip ahead and have countries stand only based on Overall Risk. You could display Chart 1 "CO_2 and Climate Vulnerability" so that students could still observe the order of other categories.*

5. Display Chart 1: CO_2 and Climate Vulnerability, which indicates the order of countries for each category.

Discussion Questions:
1. Which countries were standing the most? Which countries were standing the least (or not at all)? Do you notice a relationship between climate vulnerability and per capita CO_2 emissions?

India, Philippines, Mexico, and Haiti all stood for each category. China, Bangladesh, and Malawi stood for three out of the four categories. Kenya, Argentina, Canada, the United States, and Kuwait all stood once, and Germany did not stand at all. There are a few exceptions, but in many cases, the countries that emit the least carbon were the most impacted by climate-related risks.

2. Is any country free of climate-related risks?

No. In fact, almost all of the countries in this activity were in the top 80 most impacted by Extreme Weather. All countries can be impacted negatively by climate change and as such, all countries should be invested in staying within the carbon budget.

3. Think about the risk that your country is most vulnerable to. What might the consequences of this risk factor be on your country's people?

Answers may include: Extreme Weather – damage to crops because of extreme temperatures and precipitation, structural damage, injury/illness, forced migrations or evacuations; Sea Level Rise – flooding, crop damage, forced migration/displaced people, structural damages; Agricultural Productivity Loss – hunger, malnutrition, economic ruin.

4. For countries at high risk within each category, what are some strategies they could utilize to cope with the climate-related risks that they face?

Answers may include: Extreme Weather – infrastructure (gates, walls, levees) to protect against storm surge, buildings resistant to high winds, improved irrigation techniques to combat drought; Sea Level Rise – seawalls, canals or water pumps to redirect water, improved drainage systems, reconstruct population centers away from coastal areas; Agricultural Productivity Loss – tougher seeds resistant to drought, flooding, and pests, increasing food imports.

5. Do you think your country would be able to implement such strategies in order to cope with the climate risks it faces? Why or why not?

Answers will vary. Lower income countries will most likely not be able to mitigate risk, while higher income countries will have a better chance at coping.

6. If we re-ranked the countries but this time, based on their ability to cope with the risk, how might the ranks change?

Countries in the low- and lower-middle-income brackets would move up in the rankings, meaning they would become more vulnerable. They would be less able to adapt, mitigate disasters, and provide relief for their people.

7. Display Chart 2, "CO_2 and Vulnerability Adjusted for Coping Ability." Based on the chart, ask countries who are ranked in the top 80 in terms of Adjusted Overall Risk (adjusted for coping ability) to stand up. Is there a relationship between amounts of CO_2 emitted, wealth, and overall climate risk?

Countries that emit the least CO_2 tend to be of lower income, are least able to cope with climate change, and in turn, would be the most impacted if we exceed the carbon budget.

8. How do you think countries like Somalia, Bangladesh, and Malawi feel about their place in the new rankings? What could countries in this situation do?

Countries that emit very little but have a lot to lose in the climate fight might feel like it is not fair that they must deal with the impacts of climate change on their own. They may ask for aid from wealthier nations, or may ask for the ability to use carbon to industrialize and rise out of poverty, as other more developed nations have already done.

9. How do higher income countries feel about the new rankings?

Answers will vary.

10. Consider the carbon budget. How do you think the "pie" should be divided? Which countries should have to sacrifice the most? Why?

Answers will vary.

ASSESSMENT

Students respond to the following question and back up their answer with evidence from the class activity:

In your own words, explain the concept of the carbon budget. Given the inequities of energy use, wealth, and climate change related risks around the world, do you think it is possible for countries to agree on a global solution for staying within the carbon budget? Why or why not? Be sure to consider perspectives from countries in all emissions levels, risk levels, and income levels. If your answer is "yes," explain at least three steps that could be taken to achieve this. If your answer is "no," outline at least three challenges that you think would be impossible to overcome and why.

EXTENSION

Have students explore the CAIT climate data explorer website (http://cait.wri.org), developed by the World Resources Institute. The site is a useful tool for tracking emissions data and understanding climate equity issues. Students can investigate one or all of the listed topics:

1. Historic emissions – on the country level for 186 countries and for all 50 states
2. Equity issues – taking into account development indicators, potential for action, and emissions
3. Climate pledges – those taken by countries to be achieved by 2020, and those made in advance of the December 2015 Climate Summit (UN Framework Convention on Climate Change), outlining actions for post-2020

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[1] Intergovernmental Panel on Climate Change. (2014). *Climate Change 2014 Synthesis Report Summary for Policy Makers*. Retrieved from https://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf

[2] J. Friedrich. (2014, May 21). World Resources Institute, History of Carbon Dioxide Emissions. Retrieved from https://www.wri.org/blog/2014/05/history-carbon-dioxide-emissions

[3] World Bank, World Bank Country and Lending Groups, Retrieved on 20 August 2020 from https://datahelpdesk.worldbank.org/knowledgebase/articles/906519

[4] United Nations Statistics Division. (2010). *CO_2 Emissions*.

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STUDENT WORKSHEET

Name: ______________________________ **Date:** ______________

Look at the environment timeline (the orange bar with the tree icon at the bottom of the screen) for the years that you have been assigned. As a group, discuss and answer the following questions. Be prepared to report your summary statement to the class.

Timeline Date Range: ______________________________

1. What environmental issues are present during this time?

2. What sources of energy are being used? (solar, wood, animal, coal, oil, gas, nuclear, etc.)

3. Are there any signs of environmental degradation? If so, what are they?

4. Are any protective measures enacted during this time to limit detrimental human impacts on the environment?

5. Write a statement or short paragraph that summarizes the status of human and environment interactions during your given time period.

Summary Statement:

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COUNTRY CARDS

Directions:
1. Print all 14 pages of Country Cards.
2. Color each card the COLOR listed, either by printing on colored paper or shading them in with markers or crayons.
3. Cut out the cards along the outer solid line and fold along the dotted line to form a "tent."

COLOR: Blue

Argentina

4.7 Metric Tons CO_2 per person

(9 cubes)

Argentina

Direct Climate Risk

Extreme Weather: 39 of 167

Sea Level Rise: 83 of 119

Agricultural Loss: 108 of 167

Overall Risk: 155 of 167

CARBON CRUNCH
COUNTRY CARDS

COLOR: Orange

Bangladesh

0.3 Metric Tons CO_2 per person

(1 cube)

Bangladesh

Direct Climate Risk

Extreme Weather: 3 of 167

Sea Level Rise: 13 of 119

Agricultural Loss: 84 of 167

Overall Risk: 7 of 167

COLOR: Green

(36 cubes)

17.9 Metric Tons CO_2 per person

Canada

Canada

Direct Climate Risk

Extreme Weather: 48 of 167

Sea Level Rise: 82 of 119

Agricultural Loss: 162 of 167

Overall Risk: 159 of 167

CARBON CRUNCH
COUNTRY CARDS

COLOR: Blue

(10 cubes)

4.9 Metric Tons CO_2 per person

China

China

Direct Climate Risk

Extreme Weather: 1 of 167

Sea Level Rise: 69 of 119

Agricultural Loss: 158 of 167

Overall Risk: 1 of 167

CARBON CRUNCH
COUNTRY CARDS

COLOR: Green

Germany

10.2 Metric Tons CO_2 per person

(20 cubes)

Germany

Direct Climate Risk

Extreme Weather: 131 of 167

Sea Level Rise: 81 of 119

Agricultural Loss: 161 of 167

Overall Risk: 157 of 167

CARBON CRUNCH
COUNTRY CARDS

COLOR: Red

(1 cube)

0.3 Metric Tons CO_2 per person

Haiti

Haiti

Direct Climate Risk

Extreme Weather: 40 of 167

Sea Level Rise: 55 of 119

Agricultural Loss: 17 of 167

Overall Risk: 28 of 167

CARBON CRUNCH
COUNTRY CARDS

COLOR: Orange

(3 cubes)

1.4 Metric Tons CO_2 per person

India

India

Direct Climate Risk

Extreme Weather: 2 of 167

Sea Level Rise: 76 of 119

Agricultural Loss: 23 of 167

Overall Risk: 2 of 167

CARBON CRUNCH
COUNTRY CARDS

COLOR: Orange

(1 cube)

0.3 Metric Tons CO_2 per person

Kenya

Kenya

Direct Climate Risk

Extreme Weather: 13 of 167

Sea Level Rise: 118 of 119

Agricultural Loss: 141 of 167

Overall Risk: 94 of 167

CARBON CRUNCH
COUNTRY CARDS

COLOR: Green

(60 cubes)

30.2 Metric Tons CO_2 per person

Kuwait

Kuwait

Direct Climate Risk

Extreme Weather: 148 of 167

Sea Level Rise: Not Included

Agricultural Loss: 51 of 167

Overall Risk: 148 of 167

CARBON CRUNCH
COUNTRY CARDS

COLOR: Red

Malawi

0.1 Metric Tons CO_2 per person

(0 cubes)

Malawi

Direct Climate Risk

Extreme Weather: 11 of 167

Sea Level Rise: Not Included

Agricultural Loss: 42 of 167

Overall Risk: 13 of 167

CARBON CRUNCH
COUNTRY CARDS

COLOR: Blue

Mexico

4.4 Metric Tons CO_2 per person

(9 cubes)

Mexico

Direct Climate Risk

Extreme Weather: 26 of 167

Sea Level Rise: 80 of 119

Agricultural Loss: 28 of 167

Overall Risk: 79 of 167

CARBON CRUNCH
COUNTRY CARDS

COLOR: Orange

Philippines

0.8 Metric Tons CO_2 per person

(2 cubes)

Philippines

Direct Climate Risk

Extreme Weather: 4 of 167

Sea Level Rise: 4 of 119

Agricultural Loss: 80 of 167

Overall Risk: 42 of 167

CARBON CRUNCH
COUNTRY CARDS

COLOR: Red

Somalia

0.1 Metric Tons CO_2 per person

(0 cubes)

Somalia

Direct Climate Risk

Extreme Weather: 7 of 167

Sea Level Rise: 97 of 119

Agricultural Loss: 101 of 167

Overall Risk: 50 of 167

CARBON CRUNCH
COUNTRY CARDS

COLOR: Green

United States

19.7 Metric Tons CO_2 per person

(40 cubes)

United States

Direct Climate Risk

Extreme Weather: 25 of 167

Sea Level Rise: 91 of 119

Agricultural Productivity Loss: 156 of 167

Overall Risk: 133 of 167

Data Source:
Center for Global Development, Mapping the Impacts of Climate Change, David Wheeler.

CARBON CRUNCH
CHART 1: CO_2 AND CLIMATE VULNERABILITY

CO_2 Per Capita (in metric tons)		Extreme Weather (rank of 167)	Sea Level Rise (rank of 119*)	Agricultural Productivity Loss (rank of 167)	Overall Risk (rank of 167)
Malawi	0.1	China - 1	Philippines - 4	Haiti - 17	China -1
Somalia	0.1	India - 2	Bangladesh - 13	India - 23	India - 2
Haiti	0.3	Bangladesh - 3	Haiti - 55	Mexico - 28	Bangladesh - 7
Bangladesh	0.3	Philippines - 4	China - 69	Malawi - 42	Malawi - 13
Kenya	0.3	Somalia - 7	India - 76	Kuwait - 51	Haiti - 28
Philippines	0.8	Malawi - 11	Mexico - 80	Philippines - 80	Philippines - 42
India	1.4	Kenya - 13	Germany - 81	Bangladesh - 84	Somalia - 50
Mexico	4.4	United States - 25	Canada - 82	Somalia - 101	Mexico - 79
Argentina	4.7	Mexico - 26	Argentina - 83	Argentina - 108	Kenya - 94
China	4.9	Argentina - 39	United States - 91	Kenya - 141	United States - 133
Germany	10.2	Haiti - 40	Somalia - 97	United States - 156	Kuwait - 148
Canada	17.9	Canada - 48	Kenya - 118	China - 158	Argentina - 155
United States	19.7	Germany - 131	Kuwait - data not available	Germany - 161	Germany - 157
Kuwait	30.2	Kuwait - 148	Malawi - not included*	Canada - 162	Canada - 159

Source: Center for Global Development. *Mapping the Impacts of Climate Change.*

*land-locked countries are excluded

KEY

- green = high-income
- blue = upper-middle-income
- orange = lower-middle-income
- red = low-income

WORLD POPULATION HISTORY

CARBON CRUNCH

CHART 2: CO_2 AND VULNERABILITY ADJUSTED FOR COPING ABILITY

CO_2 Per Capita (in metric tons)		Adjusted Extreme Weather (rank of 167)	Adjusted Sea Level Rise (rank of 119*)	Adjusted Agricultural Productivity Loss (rank of 167)	Adjusted Overall Risk (rank of 167)
Malawi	0.1	Somalia - 1	Somalia - 4	Somalia - 1	Somalia -1
Somalia	0.1	Bangladesh - 2	Bangladesh - 6	Haiti - 19	Malawi - 15
Haiti	0.3	China - 3	Haiti - 20	Malawi - 20	Bangladesh - 17
Bangladesh	0.3	India - 4	Philippines -28	Bangladesh - 32	India - 21
Kenya	0.3	Malawi - 8	India - 43	India - 45	Haiti - 23
Philippines	0.8	Philippines - 10	China - 53	Philippines - 73	China - 34
India	1.4	Kenya - 15	Argentina - 67	Mexico - 93	Philippines - 60
Mexico	4.4	Haiti - 29	Kenya - 85	Kenya - 94	Kenya - 71
Argentina	4.7	Mexico - 41	Mexico - 89	Argentina - 104	Mexico - 97
China	4.9	Argentina - 51	Germany - 111	Kuwait - 116	Canada - 114
Germany	10.2	United States - 63	Canada - 114	China - 122	Argentina - 122
Canada	17.9	Canada - 95	United States - 117	United States - 154	Kuwait - 146
United States	19.7	Germany - 143	Kuwait - data not available	Germany - 156	United States - 149
Kuwait	30.2	Kuwait - 148	Malawi - not included*	Canada - 161	Germany - 156

Source: Center for Global Development. *Mapping the Impacts of Climate Change.*

*land-locked countries are excluded

KEY

- = high-income (green)
- = upper-middle-income (blue)
- = lower-middle-income (orange)
- = low-income (red)

CARBON CRUNCH
STUDENT READING

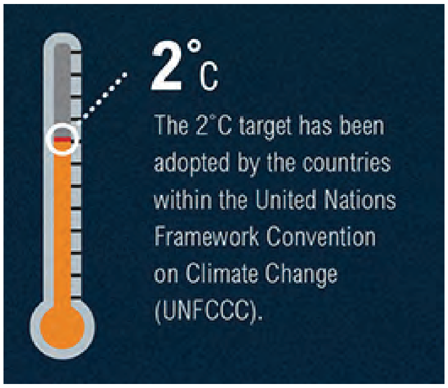
The Global Carbon Budget – How Do We Divide the Pie?

Carbon emissions have been steadily increasing since the 19th century. This drastic rise in atmospheric carbon dioxide is two-fold – it is the result of the Industrial Revolution and the dawn of fossil fuel use, as well as an increasing population and a growing demand for energy and produced goods. Levels of CO_2 are now at their highest point in all of human history. In 2011, when world population hit 7 billion, emissions were 150 times higher than they were in 1850 when world population was just over 1 billion.[1] But this energy revolution did not occur equitably around the globe. Energy intensive lifestyles are a mark of wealthy nations while many lower income countries still rely on natural energy sources like wood, sun, and animal labor to power their lives.

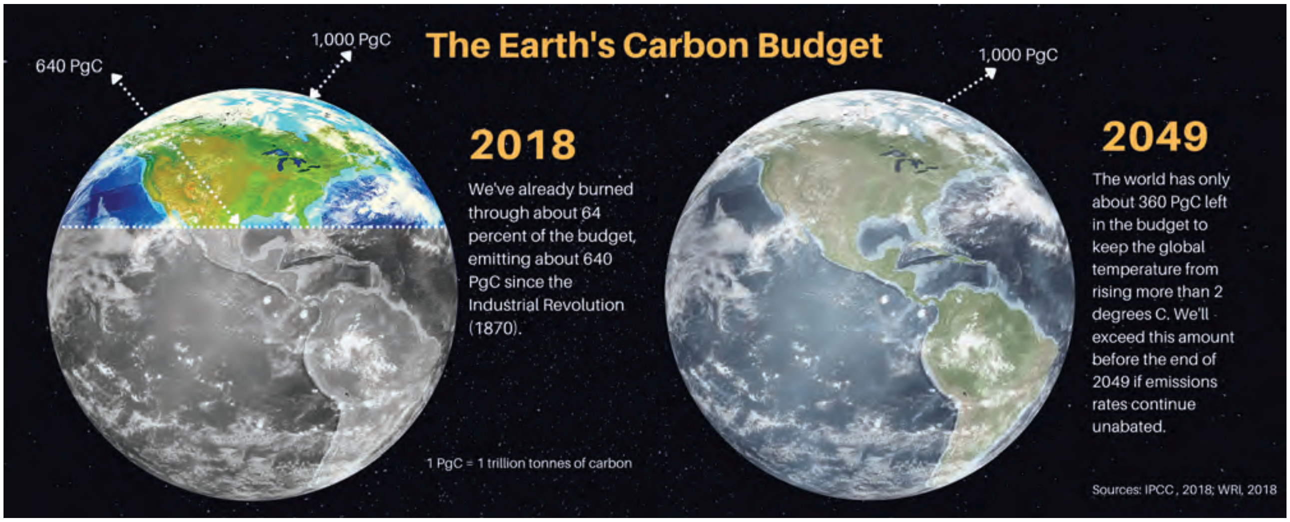
2 Degrees Celsius and the Carbon Budget

Increases in atmospheric CO_2 means higher global temperatures and more changes in weather and climate patterns. In 1988, the United Nations Environment Program (UNEP) and the World Meteorological Organization (WMO) established the Intergovernmental Panel on Climate Change (IPCC) to, "provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts." The IPCC remains the world's largest collection of climate scientists.

The IPCC, and in turn the international community, has cautioned we must keep planetary warming within 2 degrees Celsius above pre-industrial levels, if not a more ambitious 1.5 degree C limited increase or be faced with "dangerous" climate-related consequences. These would include destabilization of the polar ice caps, increases in severe weather (stronger storms, changes in precipitation, extreme temperatures, forest fires), agricultural productivity loss, and sea level rise.



In 2013, the IPCC released a groundbreaking report which asserted that as a global society, we must adhere to a "carbon budget" if we want at least a 66% chance of staying below that 2 degree Celsius target. According to their calculations, this budget allows for 1 trillion metric tons of carbon to be emitted into the atmosphere from the Industrial Era on. The calculations begin in the Industrial Era to account for the fact that CO_2 remains stored in the atmosphere for centuries after it is emitted. While 1 trillion tons sounds like a very large number, we've actually already churned through more than half of the budget. And at the rate we are going, we would exhaust the budget for a 2°C increase by 2049, and a 1.5°C increase by 2030.[2]



Limiting warming with the speed and scale necessary to avoid irreversible damage to the planet "requires major and immediate transformation" across technologies, sectors, and geographic regions.[3] Considering our energy intensive ways, this may prove to be very difficult.

The Path Forward

How might we go about divvying up the remainder of our "carbon pie"? The international community agrees that big changes need to be made, but there is no consensus on a clear route forward. One idea is that the budget could be divided based on the percentage of CO_2 that each country currently emits. This would give the U.S. a hefty 15 percent and China 28 percent.[4] However, given the inequity in energy use around the globe today, this would not be popular with nations that have yet to fully industrialize. In this scenario, low carbon countries would not be able to increase energy use in order to boost their economies and lift their people out of poverty. Energy-poor countries often point to the fact they have not contributed to the climate crisis the way big emitters have, and that they will need to use more energy in the future to ensure that the basic needs of their people are met.

Another option would be that each person gets an equal share of the pie, meaning country level emissions would essentially be based on population.[5] This would allow the opportunity for industrialization in low energy areas, but there is high potential for political and economic road blocks in places like the United States which makes up 5 percent of the world's population but currently uses 20 percent of the world's energy.

Complicating the issue further is the fact that if we plow right past 1 trillion tons and atmospheric temperatures continue to rise, the impacts of climate change will disproportionately affect those who are emitting the least. In other words, the stakes are highest for those who have the least power to change our carbon trajectory.

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[1] J. Friedrich. (2014, May 21). World Resources Institute, History of Carbon Dioxide Emissions. Retrieved from https://www.wri.org/blog/2014/05/history-carbon-dioxide-emissions

[2] World Resources Institute. According to New IPCC Report, the World Is on Track to Exceed its "Carbon Budget" in 12 Years. Retrieved from https://www.wri.org/blog/2018/10/according-new-ipcc-report-world-track-exceed-its-carbon-budget-12-years

[3] World Resources Institute. 8 Things You Need to Know About the IPCC 1.5˚C Report. Retrieved from https://www.wri.org/blog/2018/10/8-things-you-need-know-about-ipcc-15-c-report

[4] Global Carbon Budget 2019. Earth Systems Science Data, 11, 1783-1838, 2019.

[5] Raupach, Michael R., et. al. (2014), Sharing a Quota on Cumulative Carbon Emissions [Climate Change]. Nature, 4, 391-458.

Image sources: World Resources Institute. Infographic: The Global Carbon Budget. Retrieved from https://www.wri.org/resources/data-visualizations/infographic-global-carbon-budget