Solutions: The Game - **Teacher's Guide**

This activity introduces your students to a range of climate solutions in an exciting board game based on **discussion, decision-making and teamwork**! Dive deep into the world of **climate solutions,** and maybe you'll come back with an idea or two for your school to implement.

Solutions: The Game (https://solutionsthegame.com/) is inspired by cutting-edge climate science from Project Drawdown, Project Regenation, and many other sources. Every year, global temperatures increase - so in order to keep the Earth cool, your students must propose solutions. But some solutions can have more impact than others!

This is a great way for students to learn what solutions may be most effective in tackling climate change. It's suitable both for those who are new to, or more knowledgeable on, the subject.

Playing *Solutions*: The Game!

1. **Background knowledge:** Assign the **Student Handout** below to your students as reading, or use the content as a lesson. If you are already familiar with teaching climate science to students, feel free to disregard this step. The important thing is that your students understand:
    a. The underlying causes of climate change
    b. The importance of different greenhouse gases
    c. The relationship between greenhouse gases and temperature
    d. Feedback loops
    e. Types of solutions (reducing vs sequestering)
    f. Important terms and abbreviations such as GT, CO_2e, hectare, TWh

If you would like your students to learn more about the background to climate change before playing, they can also use the crash course here:
https://climatescience.org/advanced-crash-course-climate-change

2. **How to play:** Familiarize yourself with the instructions:
https://solutionsthegame.com/how-to-play/
    a. (OPTIONAL) assign the instructions to your students for homework before game day

3. **Number of players:** We suggest 5-6 players per game for optimal discussion and to avoid shy students being left out, but you can play up to 8 players per game
    a. If you only have 1 copy, you can play the game with the whole class by putting the game board on an overhead projector and showing the cards

4. **Playing time:** A game of Solutions lasts around **60-90 minutes**. Alternatively, you can flip the game board over to play **'short mode', which lasts 30-45 minutes**. Because this is a discussion-based game, playing time varies depending on how much time your students take for discussion. If students are engrossed in long discussions, it is up to your discretion whether or not you hurry them along. Allowing these deep discussions may be more valuable than finishing the game. If time is running out, you can instruct students that the game will end on an earlier turn than the final '2050' turn.

5. **Suggested age range:** Ages 10+. The game works well for elementary, high school, bachelor's, master's, and PhD students, with discussions scaling to the level of people in the room.

To play an online version of the game with your class, visit the link below:
https://solutionsthegame.com/virtual/

Otherwise, the game is available for purchase here: https://solutionsthegame.com/educators/

After playing

There are multiple options to **keep the discussion going, link to curriculum or turn ideas into action** after playing! Here are some suggestions:

1. **Linking knowledge to the carbon cycle**

Give a card to each pair of students and ask them to figure out exactly how the solution alters the carbon cycle to lower the amount of carbon in the atmosphere. Additionally, they can annotate diagrams of the carbon cycle. Thanks to Alida Melse for this suggestion!

2. **Follow-up questions**

Some possible questions are suggested on the next page - or feel free to make up your own!

3. **Real-world projects**

Hands-on projects empower students to take the ideas learned in the Solutions board game and apply their creativity to them. Types of projects can include:

- *Individual projects.* For example, a student could:
    - Write a creative essay about their favorite solution
    - Write a mock application for a job relating to one of these solutions
    - Develop a science fair project based on one of the solutions

- *Group research projects.* For example, groups of students could research and present on how a particular solution affects your local context.

- *Real-world projects.* A bigger challenge, this is likely the most meaningful and inspiring type of project that students can undertake. Suggestions of how this could be run, including project ideas, are detailed below the question sheet.

Follow-up questions

Which solution surprised you most? Why?

_____

_____

_____

_____

Which solution do you think you could use to make the biggest difference in your everyday life?

_____

_____

_____

Imagine you turn one of the solutions into a project with your **classmates** to make your **school** more sustainable. Which solution do you think could have the most impact and why?

_____

_____

_____

_____

Imagine you turn one of the solutions into a project with your **parents** to make your **community** more sustainable. Which solution do you think could have the most impact and why?

_____

_____

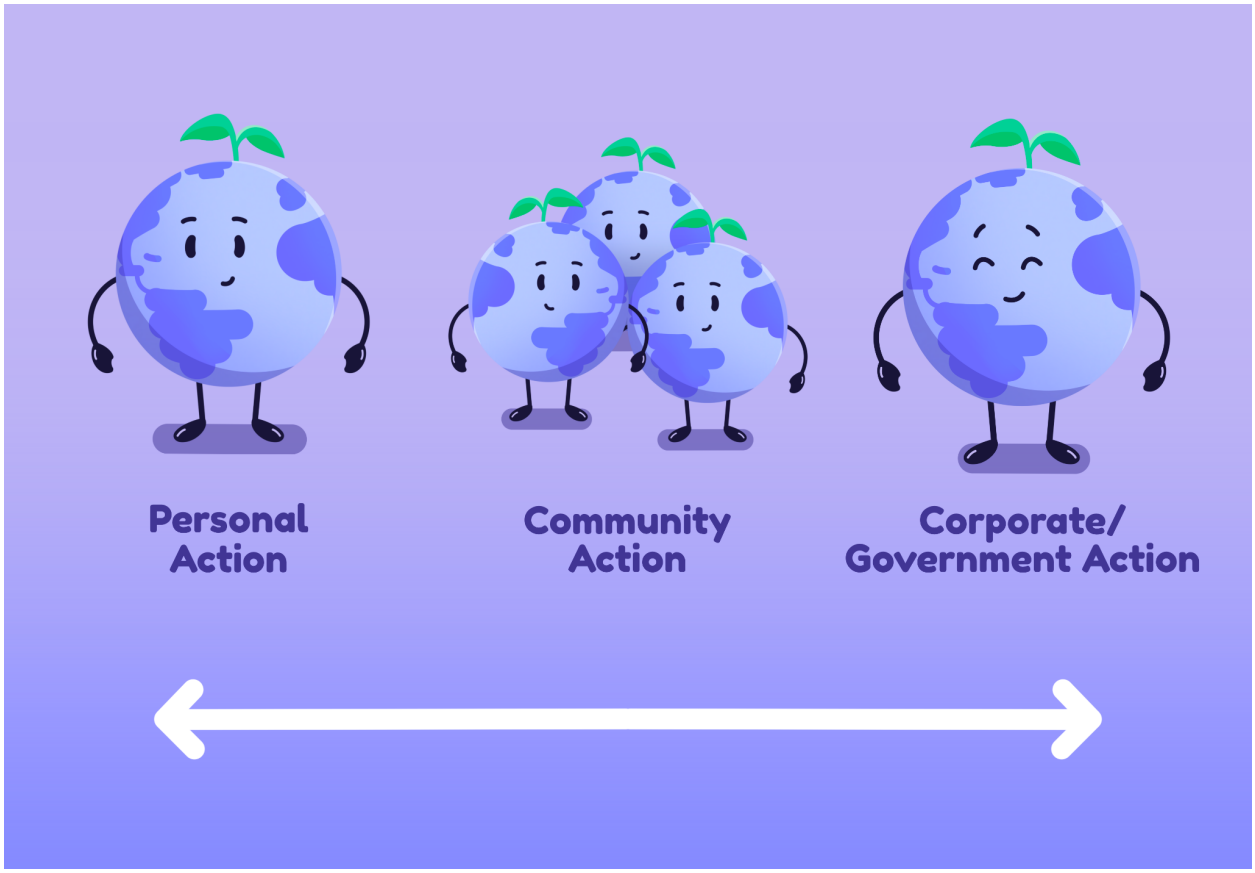
_____

_____

Hands-on learning - project ideas

Real-world projects

People often focus on the two extremes for climate action: personal actions that can seem pointless, and large actions such as national policy or technology advances which are out of the sphere of influence of most people, especially students. But the sphere of action in between - community action - is incredibly important and empowering.



Real-world projects teach students that small groups can work together to create meaningful change that impacts many more people. Watch the video at this link for inspiration on how an elementary school took action to reduce food waste at their school cafeteria: https://solutionsthegame.com/take-action/.

Notice in the video how a handful of students have introduced three systemic changes in their school that will impact not just their class, not just their grade, but every single student that attends the school in the future.

Brainstorming

1. Assign homework: Each student picks the top 5 solutions they're most interested in. They can choose solutions from the game, from the Regeneration list, or they can make up their own solutions. They must rank the solutions in order of interest.
2. In class:
    a. Choose whether you would like to do a single group project as a class, split the students into smaller groups, or do individual projects.
        i. Put the students into groups of 3-6. If possible, group students who are interested in similar solutions
        ii. Aggregate the students' choices and tally the top X solutions, where X is the number of groups you have. E.g. if you have 24 students and 6 groups of 4, choose 6 solutions. Assign 1 solution per group, based on the interests of the students.
        iii. Each group must brainstorm practical ways to implement their assigned solution in the school. Challenge them to brainstorm ideas in multiple spheres of influence. For example, a solution might be implemented in a single classroom, in a section of the school (e.g. cafeteria, garden, roof), across the entire school (e.g. LED lightbulbs), or outside the school itself (e.g. carpooling).
        iv. After 15-20 minutes, the students should switch from brainstorming to honing in on 1-3 of their favorite ideas. If it helps, students can rank the ideas based on:
            1. Their level of interest
            2. How impactful the idea is
            3. How realistic it is to implement
        v. After 20-30 minutes, each group should pick 1-2 students to present the idea to the class. After each presentation, leave 5 minutes for discussion from the rest of the class.
        vi. Voting:
            1. For single class projects, the class can then vote on which idea to implement together
            2. For group projects, each group can then choose their final project after receiving feedback from the class
            3. For individual projects, each student can then choose their own project

If your students do real-world projects, we would love to see them! Click the link here to see how you can share your classroom's story with us: https://solutionsthegame.com/share/

About this lesson plan

This lesson plan was developed in collaboration with ClimateScience, a leading organization in climate education. ClimateScience engages young people across 172 countries via schools, social media and online courses. You can learn more about Climate Science at www.climatescience.org

Solutions: The Game - **Student Handout**

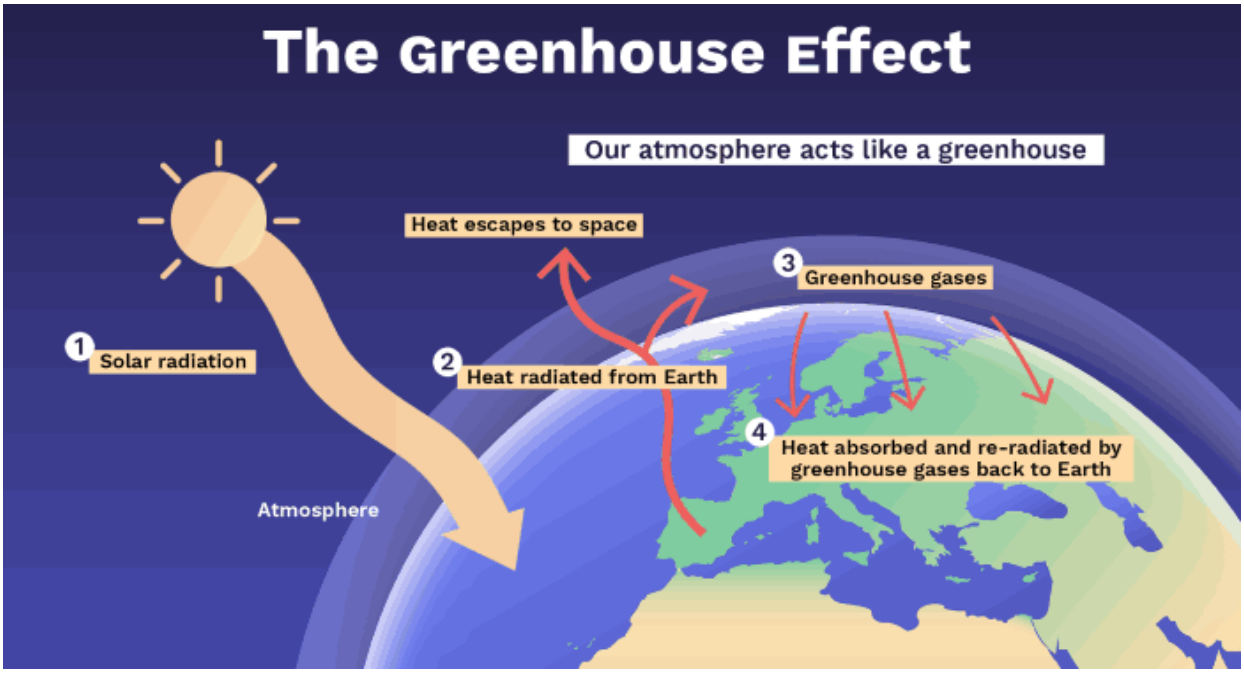
Climate change is a major threat to the environment and to the lives of **millions of people**. It will take lots of ideas and people working together to solve, though there are many possible solutions**.** But it's all relative! Some solutions may be more effective than others.

Today, you'll be learning all about these solutions and the scale of their impacts. Read the background information below and use what you've learned to help you play **Solutions**: a game in which you and your classmates must work together to **reduce global emissions** before it's too late!

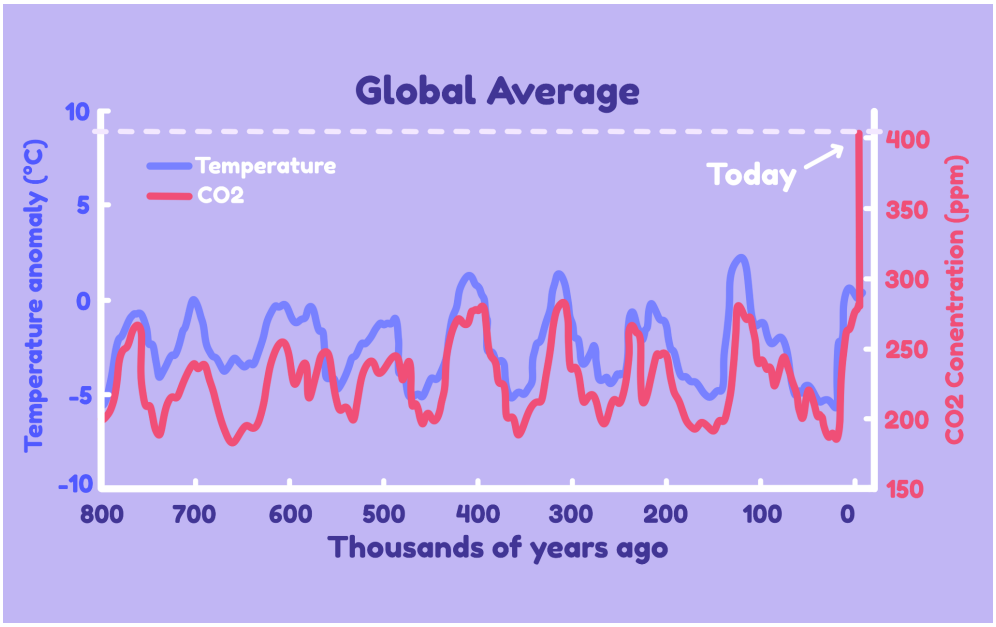
Why is climate change happening?

To know how to tackle climate change, we first need to understand **why** it happens. The answer is quite simple: climate change is caused by **humans emitting greenhouse gases into the atmosphere.**

Greenhouse gases (GHGs) help trap heat in the atmosphere, like a blanket over the Earth. They include gases such as carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O), which are naturally present in the atmosphere. Some amounts of greenhouse gas *are necessary* for life to exist. However, humans have emitted such large quantities of GHGs, like throwing more and more blankets on the Earth, that too much heat is getting trapped and causing global warming.



The most important greenhouse gas is CO_2, and as CO_2 levels have naturally fluctuated through the Earth's history, global temperatures have followed (you can see this is the graph below). However, in the Industrial Revolution, humans starting pumping massive amounts of CO_2 into the atmosphere, at a faster rate than at any other time in history. That's the recent spike in red.

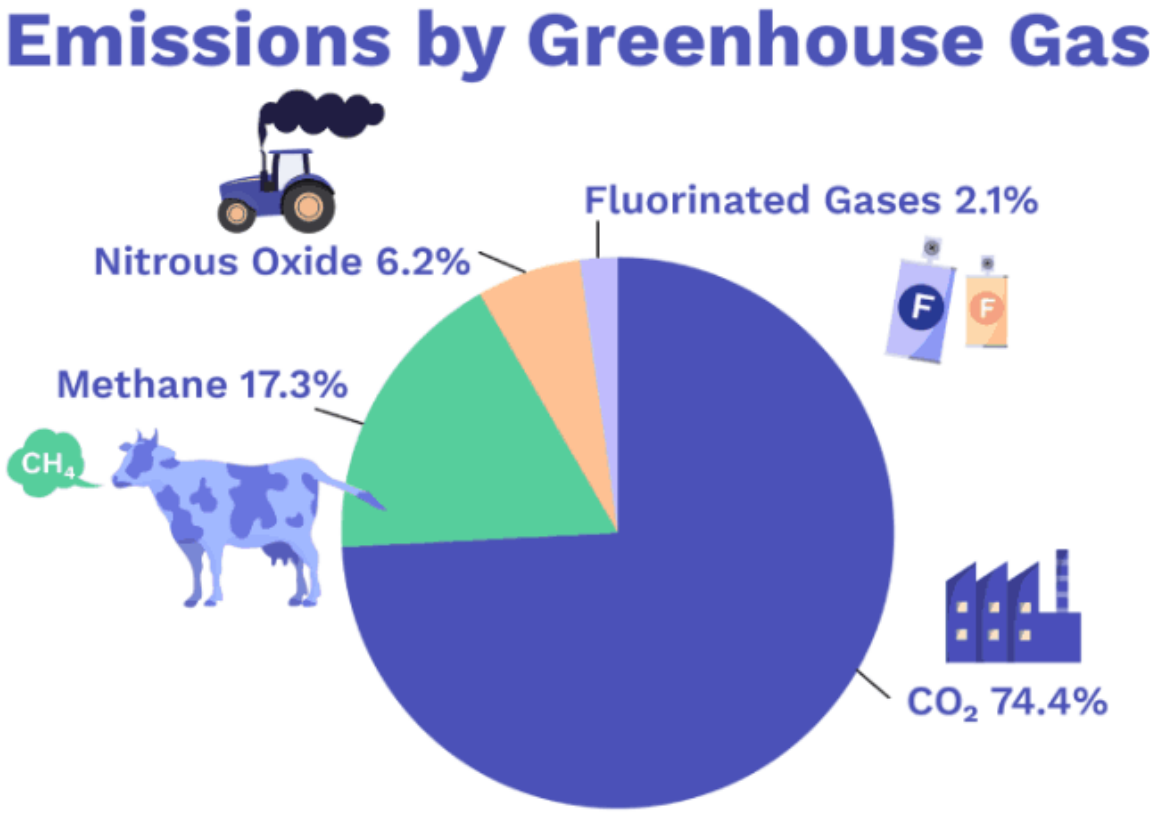


Types of GHGs

There are many different greenhouse gases, with CO_2 being the gas that contributes the most to global warming. Some of the other important greenhouse gases are less common, but have a larger impact on the climate than CO_2 on a per-unit basis. Since CO_2 is the greenhouse gas that contributes the most to global warming, we simplify things by comparing all greenhouse gases to the impact of CO_2. We do this using the term **"CO_2 equivalent" (CO_2e).** For example, methane causes up to 34x more warming than the same amount of CO_2 would do over 100 years.

Here are some of the most important greenhouse gases are with their CO_2 equivalents:

- **Methane (CH_4)** is a GHG that causes 86x more warming than **CO_2** over 20 years, although it stays in the atmosphere for only 12 years on average. It is up to 34x more potent than **CO_2** in terms of global warming potential over 100 years.
- **Nitrous oxide (N_2O)** causes up to 298x more warming than the same amount of **CO_2** would do over 100 years.
- **Refrigerants** (Fluorinated gases) such as Freon (now banned) and R-134a are used in refrigerators and air conditioners. They cause up to 10,000x more warming than the same amount of **CO_2** would do over 100 years.



Source: World Resource Institute- [World Greenhouse Gas Emissions: 2016].

Above is the breakdown of how much of each gas humans are producing, based on $GtCO_2e$ (i.e. how much each contributes to warming). In 2020, humans emitted 31.5 gigatonnes of CO2 into the atmosphere. That's 31,500,000,000 tonnes, or 31,500,000,000,000 kg!

Feedback loops

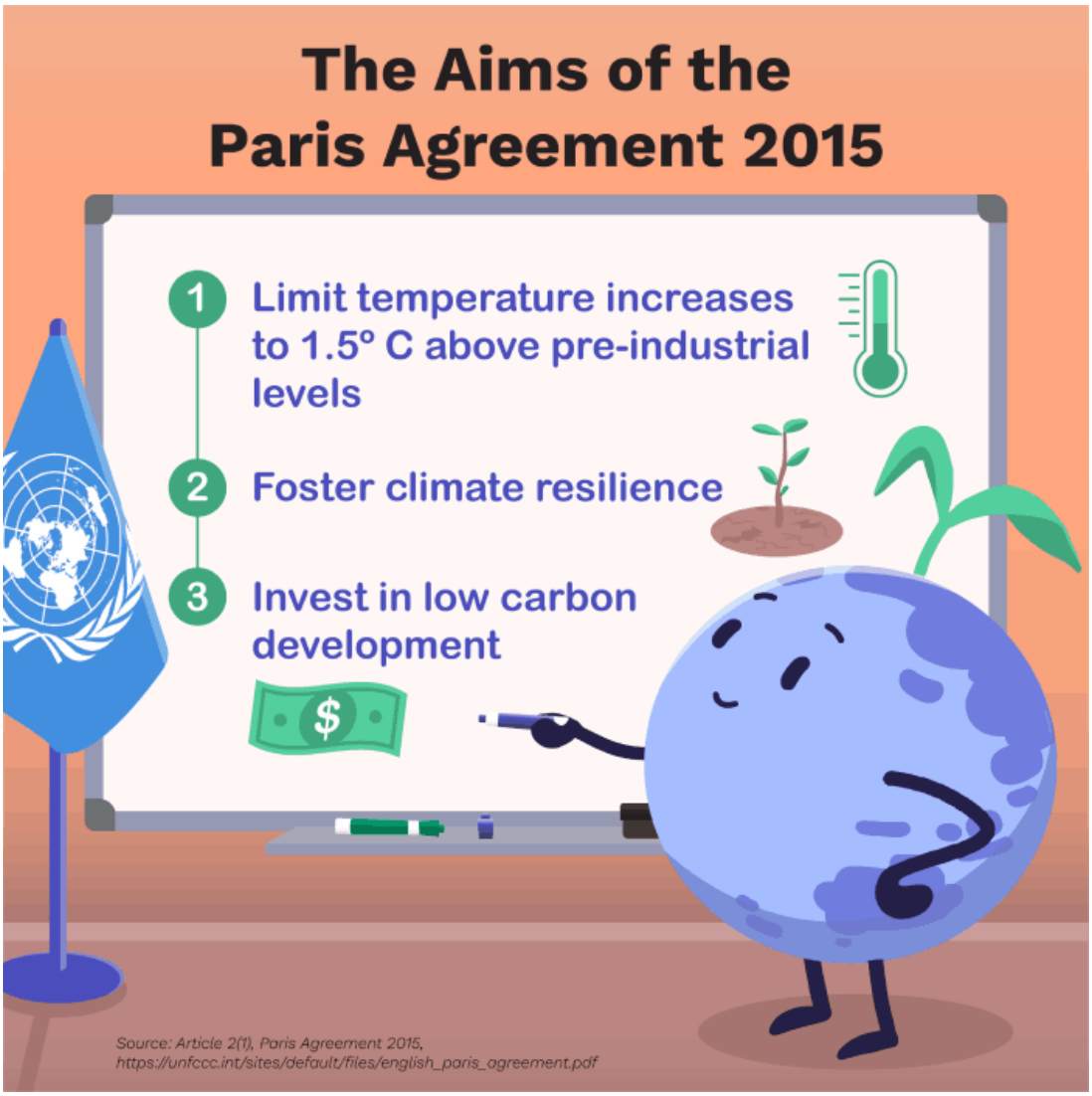
As global temperature increases, it becomes more and more likely that the Earth will experience climate feedback loops. Feedback loops are processes where increasing temperatures trigger even more warming, contributing to a vicious cycle.

You can learn more about feedback loops through this ClimateScience course here: https://climatescience.org/advanced-climate-climate-tipping-points

The solutions to our climate crisis

What we need to do - the Paris Agreement

The 2015 Paris Agreement's central aim is to "strengthen the global response to the threat of climate change by keeping global temperature rise this century well below 2 ℃ above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 ℃." However, many scientists estimate that an increase of 2 ℃ would be catastrophic.
You can learn more about the Paris Agreement here:
https://climatescience.org/advanced-climate-politics-history



How we can do it

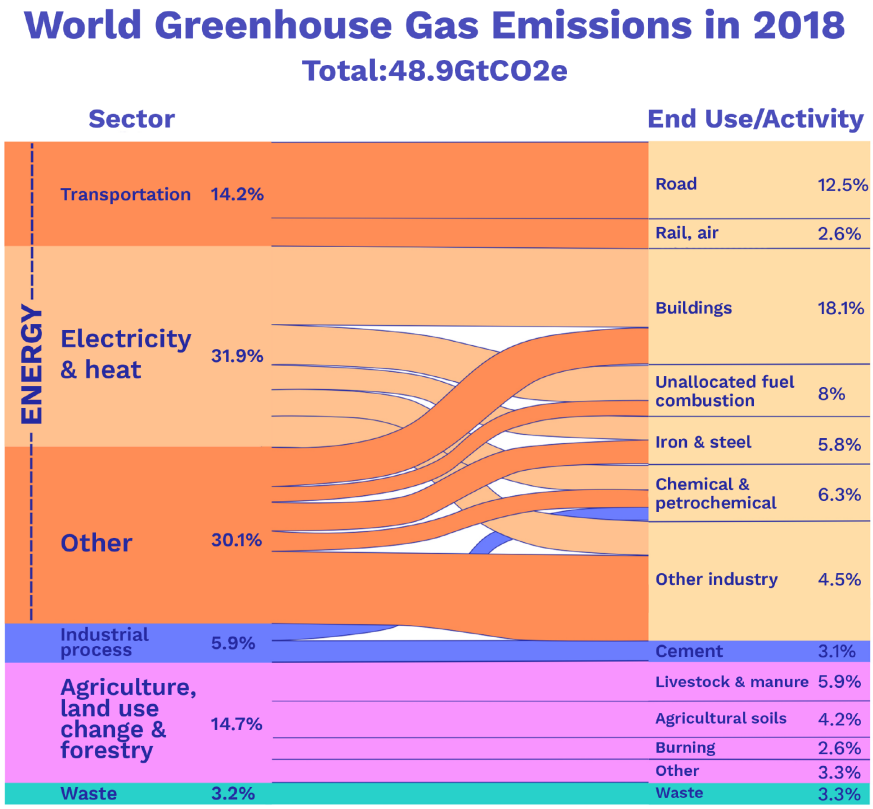
There are **MANY** solutions that need to be implemented **together** to solve climate change. Some of these include generating power from renewable sources like **wind** and **solar** rather than fossil fuels; reducing how much people consume in high-income countries;, and **many more**!

Climate solutions can reduce the amount of greenhouse gases in the atmosphere in one of two ways:

1. By reducing how much greenhouse gases are released into the atmosphere
2. By removing carbon dioxide from the atmosphere and sequestering it ('locking it away') in the land or oceans.

Some solutions can do both!

The chart below shows the pathways through which carbon flows into the atmosphere from human sources. *Pay close attention to the percentages next to each source! This might give you a clue as to which solutions might have the most impact.*



Source: https://www.wri.org/data/world-greenhouse-gas-emissions-2018

The solutions in the Solutions board game are ranked in terms of how much CO_2e they can reduce between 2020-2050. This research is based on The Drawdown Review (2020) published by Project Drawdown. They took a team of 200+ experts and analyzed over 100 climate solutions to come up with these numbers. If you ever want to dive into the research behind a solution, simply scan the QR code on the back of the card to read their research.

There are many other sources of research in the game, including from Project Regeneration, NASA, the IPCC, UNFCCC, NOAA, Yale, Stanford, the World Resources Institute, the World Economic Forum, the AMPERE Database, and more.

Solutions: The Game!

Now for the **fun** part! It's your turn to make the decisions:. every year, global temperatures increase, and you must propose solutions in order to keep the Earth cool. But some solutions can have more impact than others! **Race against the rising temperatures** so you and your classmates can live in a cool and environmentally sustainable world.

👉 Before playing the game, read the instructions here:
https://solutionsthegame.com/how-to-play/