



Climate Change Lesson 3: *The Engineer*

Student Handout

Directions

Greenhouse gases are gases that absorb heat from the sun and trap that heat in the atmosphere. But where do they come from? Some are naturally occurring in the atmosphere, but most of the greenhouse gases now in the atmosphere have been caused by human activity. When we fly in planes, drive cars, generate electricity, manufacture goods, and produce agriculture, we produce greenhouse gases. In fact, we've produced so many greenhouse gases that the global temperature has increased more than 1 degrees Celsius since the late 19th century, and 2016 ranked as the warmest year on record! An increase in global temperature has an impact on the climate and can lead to devastating changes on our planet, such as the melting of polar ice caps, a rise in sea levels, and unpredictable weather patterns.

Your *Engineer* task today is to:

1. Analyze data from a variety of graphs in order to evaluate:
 - US greenhouse gas emissions.
 - Sources of greenhouse gas emissions.
 - Human population growth rates.
2. Calculate and analyze your own carbon footprint.
3. Research a leading source of greenhouse gas emissions and design a solution to decrease the carbon footprint associated with this source.



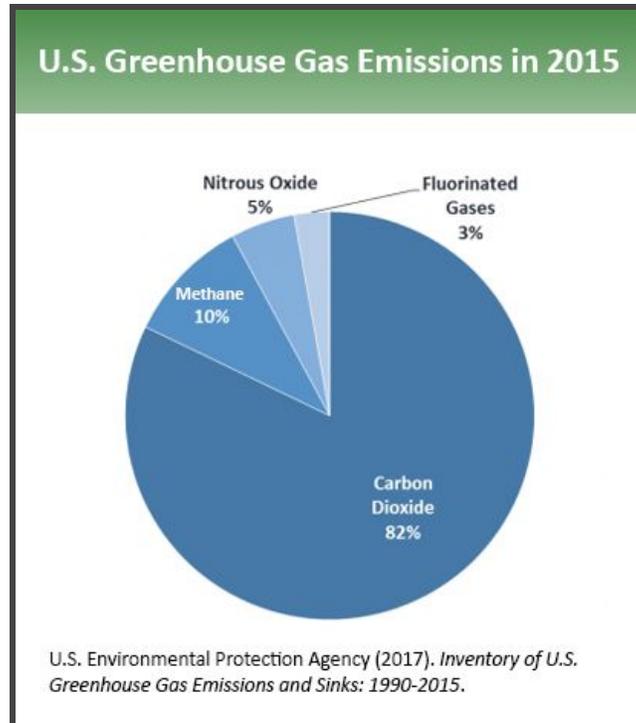
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Planning Organizer

Part 1: Interpreting Graphs

Discover how our human population is changing and what's going on with greenhouse gases by examining the graphs below! Answer the questions below each graph to analyze the data.

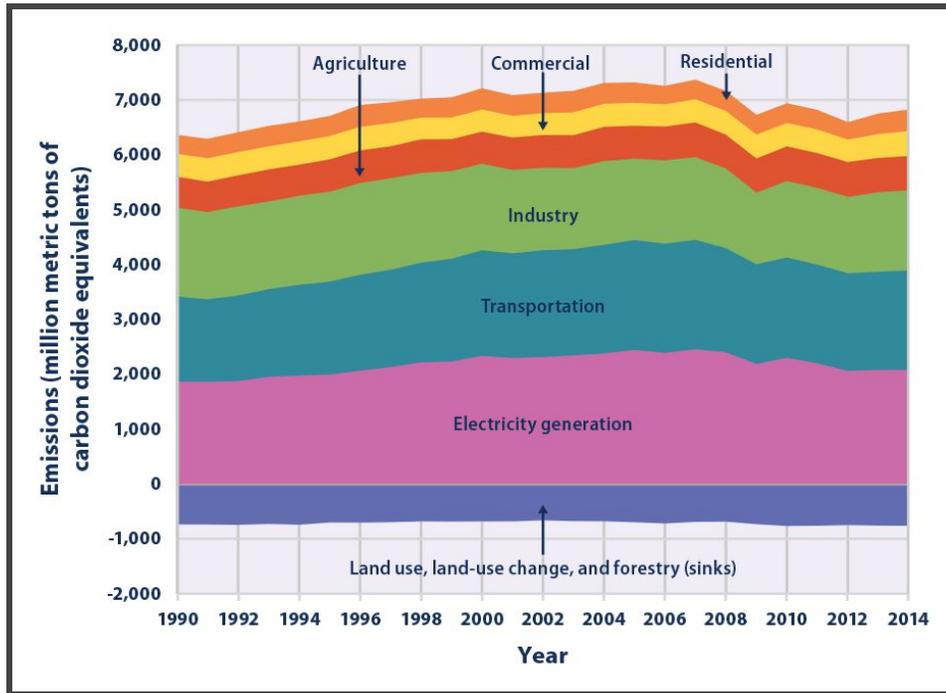


In the US, which type of greenhouse gas has the highest emissions?



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Source: U.S. EPA, 2016

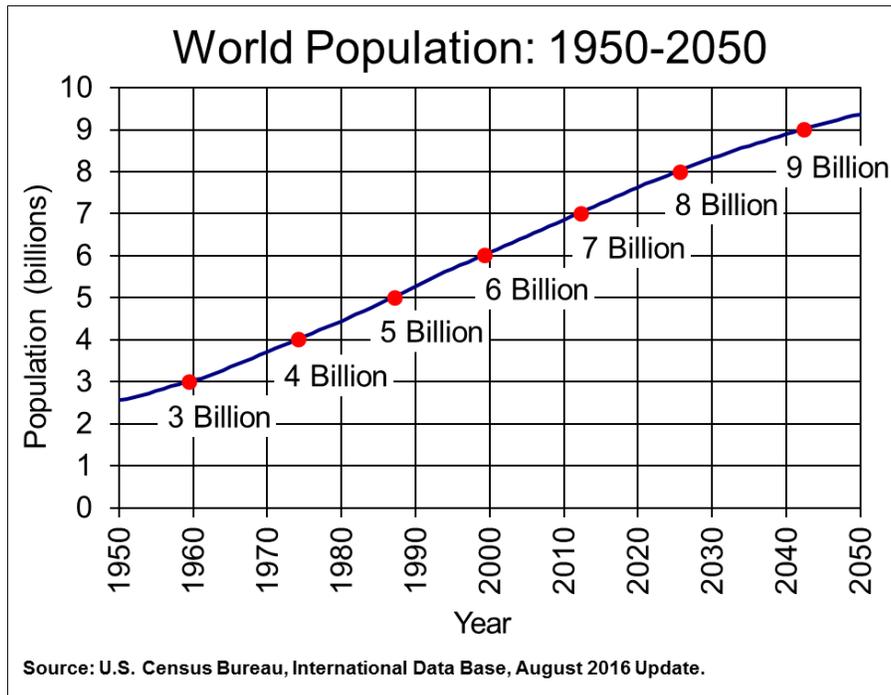
What is our greatest source of greenhouse gas emissions?

How do you predict these greenhouse emissions might change as the human population increases?



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How has the human world population changed over time?

How much did the population increase between 1960 and 2000?

According to this graph, what is the current human population?

How do you predict the population will change in the future?



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Part 2: Your Carbon Footprint

How are you contributing to greenhouse gas emissions on our planet? Calculate your carbon footprint to find out!

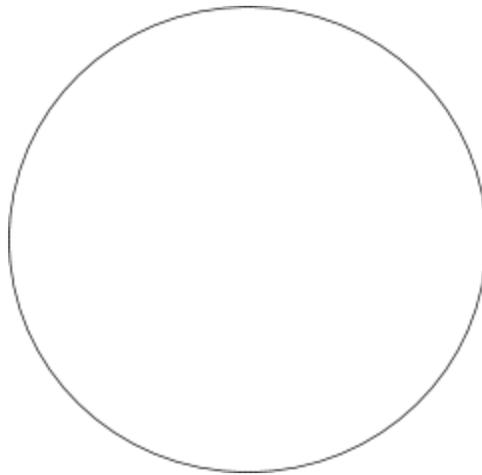
Use the *Lehigh University Environmental Initiative* website to calculate your carbon footprint.

**Carbon footprint is the amount of greenhouse gases produced as a result of your daily activities.*

<http://www.ei.lehigh.edu/learners/cc/carboncalc.html>

Once completed, answer the following questions.

Create a pie chart to show your carbon emission data.



Record the average US emission data in each category.

Household: _____ Transportation: _____ Food: _____

How does your carbon footprint data compare with the average US emission data? Explain.

What actions could you take to reduce your carbon footprint? Explain.



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Part 3: Designing Solutions

Choose **ONE** source of greenhouse gas emissions to research. Your teacher will provide you with a Source Card that you will use as the focus for this project.

Fill in the research data table below for your greenhouse gas source of choice by researching your source at the following link to the Environmental Protection Agency's (EPA) website:

<https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions>

Greenhouse Gas Source Background Research	
Identify US greenhouse gas source focus	
What percentage of total greenhouse gas emissions are produced by this source?	
What type of greenhouse gases are being produced by this source?	
How are these greenhouse gases being produced by this source?	
Environmental Impact	
How do the greenhouse gases produced by this source negatively impact on the environment?	



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If the problem you described above continues, what could happen to the environment?	
Describe existing practices that help reduce the greenhouse gases produced by this source?	



Create Your Solution

1. Plan	
A. How can you further reduce greenhouse gas emissions from your researched source? Brainstorm some ideas in the space provided.	
B. Will you design a model to show how your solution works or will you design a campaign to present your solution to the public? Circle one below: Model Campaign	

Choose Your Best Idea to Move Forward





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C. What are your solution requirements? What are some possible constraints (limitations) to consider? *For example, a requirement may be size or usability; a limitation may be cost or space.*

Requirements	Limitations

D. Will your solution be a new idea (an invention) or will it improve upon an existing design/plan (innovation)?

E. How does your design solution meet the needs of this problem?

F. What are some **tradeoffs** to this solution? List the advantages and disadvantages of your solution below.

Advantages	Disadvantages



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G. If you're building a model, identify materials you'll need. If you don't have access to the real-world materials, explain what you'll be using to represent these materials. For example, you might use aluminum foil to represent steel in your build.

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Teacher Approval Stamp





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2. Create

With the above plan in mind, now it's time to create your solution. Choose the format in which you'll be presenting your solution: either Option A, building a model, or Option B, creating a campaign. Your teacher will specify the amount of time you have.

Option A. Build a Model

Using the approved materials, and being conscientious of others' material needs, build your device. When you're done with your build, create a visual aid of your product that includes:

- Title
- Greenhouse gas source researched facts
- Environmental impact researched facts
- An explanation of how your model works and how it will help to reduce greenhouse gas emissions produced by your source
- A convincing argument as to why the public should use your solution to reduce greenhouse gas emissions
- Sketch/blueprint of model showing proper dimensions
- Explanations of all parts and how they contribute to the product

Option B. Create a Campaign

Choose how you will present your campaign (billboard, informative brochure, town hall meeting presentation using either PowerPoint or Google Slideshow, infographic flyer, video etc.) Be sure the campaign includes:

- Title
- Greenhouse gas source research facts
- Environmental impact research facts
- An explanation of how your solution works to reduce greenhouse gas emissions produced by your source
- A convincing argument using evidence as to why the public should use your solution to reduce greenhouse gas emissions
- One or more graphic displays of data included in your presentation (greenhouse gas emission data, environmental impact data, etc.)



3. Present

You will have **5 minutes** to present your reduction of greenhouse gases solution to an audience.

- Be sure to give an informative presentation in order to:
 - Educate the audience about your researched source of greenhouse gas emissions and environmental impact due to these gas emissions.
 - Inform audience members about your proposed solution to limit greenhouse gases produced by your source.
 - Convince audience members to adopt your solution in order to help reduce their own carbon footprints and improve the environment.

Optional: If approved by your teacher, include appropriate music/song to enhance your presentation (make sure it's not a distraction).



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Climate Change *The Engineer* Assessment

Use the Checklist and Science & Engineering Practices Rubric to ensure you have addressed all aspects of *The Engineer* with quality work.

Climate Change *The Engineer* Checklist: Content Concepts and Practices

Your Challenge: Research a leading source of greenhouse gas emissions and design a solution to decrease the carbon footprint associated with this source.

Project Completion:

- Completion of all aspects of Engineering Planning Guide including:
 - Gas Emission and World Population graph analysis questions completed and answered thoroughly.
 - Carbon footprint graph and data completed along with corresponding analysis questions.
 - Research on greenhouse gas source and environmental impact
 - Planning template for design solution
- Option A: Model includes:
 - Title
 - Greenhouse gas source researched facts
 - Environmental impact researched facts
 - An explanation of how model works and how it will help to reduce greenhouse gas emissions produced by source
 - A convincing argument as to why the public should use solution to reduce greenhouse gas emissions
 - Sketch/blueprint of model showing proper dimensions
 - Explanations of all parts and how they contribute to the product
- Option B: Campaign includes:
 - Title
 - Greenhouse gas source research facts
 - Environmental impact research facts
 - An explanation of how solution works to reduce greenhouse gas emissions produced by your source
 - A convincing argument using evidence as to why the public should use solution(s) to reduce greenhouse gas emissions
 - One or more graphic displays of data included in presentation (greenhouse gas emission data, environmental impact data, etc.)

DCI Standards Checklist:

- Accuracy of graph interpretation and analysis for all relevant graphs regarding greenhouse gas emissions, world population and carbon footprint
- Accurate understanding and communication of relevant data regarding researched source of greenhouse gas and environmental impacts
- Design solution is realistic, relevant and could accurately be used to alleviate greenhouse gas source and environmental impacts.



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- ❑ Informative explanation of how design solution works to limit greenhouse gases produced by source
- ❑ Presentation convinces audience members to adopt solution in order to help reduce their own carbon footprints and improve the environment

Science & Engineering Practices Assessed

	Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Analyzing and Interpreting Data	Constructs data tables or graphs that do not display all data. Analyzes data with major misconceptions or omissions.	Constructs data tables or graphs that displays all data, but does not analyze relationships. Analyzes data with minor misconceptions.	Constructs data tables or graphs that displays all data and makes simple connections between variables. Analyzes data to provide evidence for a phenomena.	Constructs data tables or graphs that displays all data and makes complex connections between variables. Analyzes data to provide evidence for a phenomena and acknowledges limitations.
Constructing Explanations or Arguments From Evidence	Constructs an explanation with no clear sources of evidence.	Uses scientific principles and/or data from at least one source to construct or evaluate an explanation, but explanation contains minor misconceptions.	Uses accurate but incomplete scientific principles and/or data from multiple sources to construct or evaluate an explanation.	Uses accurate and complete scientific principles and/or data from multiple sources to construct or evaluate an explanation.
Designing Solutions	Applies no scientific principles and/or data to design, construct, and/or test a design of an object, tool, process, or system.	Applies minimal scientific principles and/or data to design, construct, and/or test a design of an object, tool, process, or system.	Applies adequate scientific principles and/or data to design, construct, and/or test a design of an object, tool, process, or system.	Applies complete scientific principles and/or data to design, construct, and/or test a design of an object, tool, process, or system.
Communicating Findings/Design (Oral Presentation)	Findings/design are incompletely and inaccurately communicated. Or no evidence of using appropriate eye contact, adequate volume, or clear pronunciation.	Findings/design are completely communicated with some misconceptions. Or uses minimal eye contact, inappropriate volume, or inconsistent pronunciation.	Findings/design are completely communicated but lacking depth and complexity. Or often uses eye contact and engaging and appropriate volume and pronunciation, but is inconsistent.	Findings/design are completely communicated with depth and complexity. Or mostly uses eye contact and engaging and appropriate volume and pronunciation.