

6.3 THE CARBON CYCLE AND OUR CARBON FOOTPRINT

How is the global community addressing their carbon footprint?

C3 Framework Indicator	D2.Civ.13.9-12. Evaluate public policies in terms of intended and unintended outcomes, and related consequences.	
Staging the Compelling Question	After learning about the original carbon cycle, students will examine how humans have changed the system, and what impact our involvement in the system has on the environment.	
Supporting Question 1	Supporting Question 2	Supporting Question 3
What are some communities doing to become carbon-neutral?	What policies can federal governments introduce to help reduce carbon outputs?	How is the German private sector responding to climate change?
Formative Performance Task	Formative Performance Task	Formative Performance Task
Students will pick a city from the resources and explore which strategies that city is using to achieve its sustainability goals, and write a short summary of those endeavors.	As a class watch the video “What is the German <i>Energiewende</i> ?” as an introduction to the concept of a national environmental plan. Students will answer the provided questions.	As a case study, look into what Siemens is doing to help achieve the United Nations Sustainable Development Goals.
Featured Sources	Featured Sources	Featured Sources
Source A: <i>Official website of the Carbon Neutral Cities Alliance</i>	Source A: <i>YouTube</i>	Source A: Sustainable Business Models (Handout 6.3.1) Source B: <i>Siemens</i>
Summative Performance Task	<p>Argument: Construct an argument (e.g., detailed outline, poster, essay) that addresses the compelling question using specific claims and relevant evidence from historical or contemporary sources while acknowledging competing views.</p> <p>Extension 1: Students will investigate sustainability efforts that are happening in their community.</p> <p>Extension 2: Ask students to complete the “How Big is your Environmental Footprint?” questionnaire.</p> <p>Extension 3: Use Handout 6.3.2 “Global Efforts to Reduce Carbon Outputs” to complete two case studies of what cities around the world are doing to reduce their carbon outputs.</p>	
Taking Informed Action	<p>Understand: As consumers we have choices, these choices drive businesses and the way they handle their sustainability efforts.</p> <p>Assess: Look deeper into the sustainability efforts of the company you researched in performance task #3.</p> <p>Act: Write a business letter to the company you researched commending the company on their current plan and making recommendations for further improvement.</p>	

? COMPELLING QUESTION

- How is the global community addressing their carbon footprint?

INQUIRY OVERVIEW

This inquiry focuses on understanding the carbon cycle and its impact on the global environment and economy. After learning about the original carbon cycle, students will examine how humans have changed the system, and what impact our involvement in the system has on the environment. Using the city of Freiburg, Germany, as a sustainability model, students will research other communities and their sustainability efforts.

Students will use the sustainability business model of Siemens as a case study as they learn about Germany's energy plan, *Energiewende*, and then research other companies' sustainability efforts. Finally, students will determine their own carbon footprint and ways they can reduce it.

Teachers may wish to provide students with an example of certain handouts instead of printing copies thus highlighting how to reduce carbon emissions by reducing paper.

TEACHER BACKGROUND

***Note:** Prior to engaging in this inquiry, students should have a solid grasp of the following concepts: global warming, climate change, and sustainability. Definitions of these terms and others can be found at Boston University Sustainability: Glossary of Terms, <http://www.bu.edu/sustainability/reference/glossary-of-terms/>.

Germany is in the midst of transforming itself from a fossil fuel-dependent, greenhouse gas producer to an international sustainability pioneer by decarbonizing its energy supplies. The term used by Germans for this process is *Energiewende* (Energy Transition) and has become synonymous with the current push for low carbon renewable energy sources throughout Germany. The speed at which

this transition has taken place is demonstrated through the following comparison: at the turn of the 21st century the United States actually generated more of its electricity from renewables than Germany, 8% versus 6% respectively. By 2017 Germany had leap-frogged the United States' 14.3% share, generating a robust 36.1% of its energy from renewable resources.¹


Most experts point to the Renewable Energy Act of 2000 (*Erneuerbare-Energien-Gesetz*, EEG) as the catalyst that led to the latest series of energy transition efforts in Germany. Despite initial opposition from conservative officials, the aspects of the law that protect private investments, including the guaranteed feed-in tariffs and grid connection requirement, caused farmers and private citizens to back the bill and thus in the end, convinced conservative members in the *Bundestag* to throw their support behind it. That is, once farmers realized that the law allowed them to produce and sell their own power at a guaranteed price-point with a cheaper buy-back rate, they exercised additional pressure on their elected representatives. Thus, the *Energiewende* has signaled a paradigm shift in both the citizenry, who now expects to have a say and take an active role in



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¹ Amelang, Soren. "Renewables cover about 100% of German power use for the first time ever." *Clean Energy Wire*, 5 January 2018, <https://www.cleanenergywire.org/news/renewables-cover-about-100-german-power-use-first-time-ever>.

energy production, and in the new corporate approach that moves from the “take, make, waste” model toward a renewable, cyclical, waste-free, and benign system based on resource productivity, in which fewer emissions and waste equals more profit. Moreover, data collected in Germany over a ten-year-period points to the overall initial success of the *Energiewende*, specifically in that period from 1990 to 2017 Germany’s greenhouse gas emissions dropped 28%.² In all, the fact that Germany, a highly developed democratic industrial power, has managed to shrink its carbon footprint while simultaneously increasing its GDP not only reinforces the overall efficacy of the policy on the domestic front, but it also serves as an example for other developed nations across the globe that are ripe for an energy transition of their own.

 **TIME:** 2–3 45 minute periods

CONCEPTS LIST

- Carbon cycle
- *Energiewende*
- Renewable energy
- Sustainability
- Low carbon economy
- Hydro power
- Biomass
- Geothermal energy
- Wind power
- Municipal waste
- Nuclear energy
- Natural gas
- Hard coal
- Lignite
- Ethanol
- Decarbonizing
- Greenhouse gas emissions
- Carbon footprint
- High-carbon process
- Low-carbon process

INSTRUCTIONAL RESOURCES

- Sustainable Business Models (**Handout 6.3.1**)
- Global Efforts to Reduce Carbon Outputs (**Handout 6.3.2**)
- “What’s the Deal with Carbon?” Exit Ticket (**Handout 6.3.3**)
- Amelang, Soren. “Renewables cover about 100% of German power use for the first time ever.” *Clean Energy Wire*, 5 January 2018, <https://www.cleanenergywire.org/news/renewables-cover-about-100-german-power-use-first-time-ever> .
- Appunn, Kerstin and Julia Wettengel. “Germany’s Greenhouse Gas Emissions and Climate Targets.” *Clean Energy Wire*, 21 March 2019, <https://www.cleanenergywire.org/factsheets/germanys-greenhouse-gas-emissions-and-climate-targets>.
- “Basic Business Letters.” *The Purdue OWL and Family of Sites*, The Writing Lab and OWL at Purdue and Purdue U, 2008, https://owl.purdue.edu/owl/subject_specific_writing/professional_technical_writing/basic_business_letters/index.html.
- “carbon-neutral.” *Merriam-Webster.com*. Merriam-Webster Dictionary Web., 2019, <https://www.merriam-webster.com/dictionary/carbon-neutral>.
- “Concrete Things You Can Do to Help Our Living Planet.” *Official website of the World Wildlife Fund: For Your World*, https://wwf.panda.org/get_involved/live_green/.
- “Global Cities Cutting Emissions by 80-100% by 2050 or Sooner.” *Official website of the Carbon Neutral Cities Alliance (CNCA)*, <https://carbonneutralcities.org/cities/>.
- “Glossary of Terms.” *Official website of Boston University Sustainability*, 2010, <http://www.bu.edu/sustainability/reference/glossary-of-terms/>.
- Gregory, Regina. “Germany—Freiburg—Green City.” *Official website of The EcoTipping Points Project*, January 2011, <http://www.ecotippingpoints.org/our-stories/indepth/germany-freiburg-sustainability-transportation-energy-green-economy.html>.

All handouts
can be found at
[www.goethe.de/
germanyinfocus](http://www.goethe.de/germanyinfocus)

² Appunn, Kerstin and Julia Wettengel. “Germany’s Greenhouse Gas Emissions and Climate Targets.” *Clean Energy Wire*, 21 March 2019, <https://www.cleanenergywire.org/factsheets/germanys-greenhouse-gas-emissions-and-climate-targets>.

- “How Big is your Environmental Footprint?” *Official website of the World Wildlife Fund: For Your World*, <https://footprint.wwf.org.uk/>.
- Siemens. “Sustainability follows our company values.” *Siemens*, 2019, <https://new.siemens.com/global/en/company/sustainability.html>.
- “Spongebob Square Pants in The Endless Summer.” *YouTube*, uploaded by NRDCflix, 15 December 2008, <http://www.youtube.com/watch?v=xlkprv-Upco>.
- “Sustainable Development Goals.” *Official website of the United Nations Development Programme*, 2019, <http://www.undp.org/content/undp/en/home/sustainable-development-goals/>.
- “What is the German *Energiewende*?” *YouTube*, uploaded by Heinrich-Böll-Stiftung, 4 February 2013, <http://www.youtube.com/watch?v=NBx49310W7k>.
- “What’s the Deal with Carbon?” *YouTube*, uploaded by BellMuseum, 12 November 2010, <http://www.youtube.com/watch?v=2Jp1D1dzxj8>.
- World Wildlife Fund. “How big is your environmental footprint?” *WWF*, 2019, <https://footprint.wwf.org.uk>.

INTRODUCTORY ACTIVITY

Watch the “Spongebob Squarepants in The Endless Summer” clip and discuss the following as a class:

- Describe the business model used by Mr. Krabs.
- What are the environmental and human impacts of this model?
- Is this model being practiced outside of this video clip?
- Is it sustainable?

► Resources

- “Spongebob Square Pants in The Endless Summer.” *YouTube*, uploaded by NRDCflix, 15 December 2008, <http://www.youtube.com/watch?v=xlkprv-Upco>.



? SUPPORTING QUESTION #1

What are some communities doing to become carbon-neutral?

► Formative Performance Task

Ask students to write a definition in their own words of what “carbon-neutral” means. Students will then choose one city that is a member of the Carbon Neutral Cities Alliance (CNCA). They should explore which strategies that city is using to achieve its sustainability goals, and write a short summary of those endeavors.

(Merriam-Webster.com, carbon-neutral: “having or resulting in no net addition of carbon dioxide to the atmosphere”)

► Resources

- “Global Cities Cutting Emissions by 80-100% by 2050 or Sooner.” *Official website of the Carbon Neutral Cities Alliance (CNCA)*, <https://carbonneutralcities.org/cities/>.
- “carbon-neutral.” *Merriam-Webster.com*, Merriam-Webster Dictionary, 2019. Web, <https://www.merriam-webster.com/dictionary/carbon-neutral>.



❓ SUPPORTING QUESTION #2

What policies can federal governments introduce to help reduce carbon outputs?

► Formative Performance Task

As a class watch the video “What is the German *Energiewende*?” as an introduction to the concept of a national environmental plan. Students should write their answers to the following three questions to demonstrate their understanding.

1. What is significant about Germany’s energy plan?
2. How does the plan incorporate the efforts of individuals?
3. What incentives are there for individuals to participate?

► Resources

“What is the German *Energiewende*?” YouTube, uploaded by Heinrich-Böll-Stiftung, 4 February 2013, <http://www.youtube.com/watch?v=NBx493I0W7k>.



❓ SUPPORTING QUESTION #3

How is the German private sector responding to climate change?

► Formative Performance Task

Unlike the business model of Mr. Krabs in “Spongebob,” many companies are working to minimize their footprint. As a case study, look into what Siemens is doing to help achieve the United Nations Sustainable Development Goals: <https://new.siemens.com/global/en/company/sustainability.html>. Students should use **Handout 6.3.1** “Sustainable Business Models” to take notes on what they learn from Siemens. Then they will continue their research with a second company and compare.

► Resources

- Sustainable Business Models (**Handout 6.3.1**)
- Siemens. “Sustainability follows our company values.” *Siemens*, 2019, <https://new.siemens.com/global/en/company/sustainability.html>.



✓ SUMMATIVE PERFORMANCE TASK

How is the global community addressing their carbon footprint?

Construct an argument (e.g., detailed outline, poster, essay) that addresses the compelling question using specific claims and relevant evidence from historical or contemporary sources while acknowledging competing views.

⊕ EXTENSION (OPTIONAL) TASK #1

Students will investigate sustainability efforts that are happening in their community. Does the community have a sustainability plan? What efforts are made by the local government and community members to reduce their carbon footprint?

⊕ EXTENSION (OPTIONAL) TASK #2

Ask students to complete the “How Big is your Environmental Footprint?” questionnaire at <https://footprint.wwf.org.uk/>.

Then they will brainstorm ways they could reduce their personal carbon footprint. They should compare their group’s ideas with the ones proposed by the World Wide Fund For Nature at https://wwf.panda.org/get_involved/live_green/.



► Resources

- “Concrete Things You Can Do to Help Our Living Planet.” *Official website of the World Wildlife Fund: For Your World*, https://wwf.panda.org/get_involved/live_green/.



⊕ EXTENSION (OPTIONAL) TASK #3

Use **Handout 6.3.2** “Global Efforts to Reduce Carbon Outputs” to complete two case studies of what cities around the world are doing to reduce their carbon outputs.

First, students will read about efforts in the city of Freiburg to create a green economy and promote environmental progress. As students find out what has been done there, students should take notes on their sustainability goals, their action plan, and the possible obstacles that may have increased their challenges.

Then they should choose a second city anywhere in the world. They will research that city’s sustainability goals, action plan, and any possible obstacles that they or those involved anticipate. They may want to start their research at the United Nations Development Programme website in the resources below.

Once students’ charts are complete, discuss the different plans, and create a master list of sustainability goals and possible obstacles.

► Resources

- Global Efforts to Reduce Carbon Outputs (**Handout 6.3.2**)
- Gregory, Regina. “Germany—Freiburg—Green City.” *Official website of The EcoTipping Points Project*, January 2011, <http://www.ecotippingpoints.org/our-stories/indepth/germany-freiburg-sustainability-transportation-energy-green-economy.html>.
- “Sustainable Development Goals.” *Official website of the United Nations Development Programme*, 2019, <http://www.undp.org/content/undp/en/home/sustainable-development-goals/>.



★ TAKING INFORMED ACTION

UNDERSTAND: As consumers we have choices, these choices drive businesses and the way they handle their sustainability efforts.

ASSESS: Look deeper into the sustainability efforts of the company you researched in performance task #3.

ACT: Write a business letter to the company you researched in performance task #3 commending the company on their current plan and making recommendations for further improvement.

For details on how to write a basic business letter, please refer to:

- “Basic Business Letters.” *The Purdue OWL and Family of Sites*, The Writing Lab and OWL at Purdue and Purdue U, 2008, https://owl.purdue.edu/owl/subject_specific_writing/professional_technical_writing/basic_business_letters/index.html.



► **Modification**

For students with limited background knowledge of this topic:

Supporting Question:

What is the carbon cycle?

Formative Performance Task:

Watch the video “What’s the Deal with Carbon?” Discuss with the class what the original carbon cycle system was and how humans have changed that system. Complete **Handout 6.3.3** “What’s the Deal with Carbon?” Exit Ticket to demonstrate your mastery of this content.

► **Resources**

- “What’s the Deal With Carbon?” Exit Ticket (**Handout 6.3.3**)
- “What’s the Deal with Carbon?” *YouTube*, uploaded by BellMuseum, 12 November 2010, <http://www.youtube.com/watch?v=2Jp1D1dzxj8>.

