

## 4.4 TECHNOLOGY AND INNOVATION

### How are German companies leading the way in innovation?

<b>C3 Framework Indicator</b>	<b>D2.Eco.7.6-8.</b> Analyze the role of innovation and entrepreneurship in a market economy.	
<b>Staging the Compelling Question</b>	Students will learn about the concept of innovation and investigate German industries that are leaders in innovation.	
<b>Supporting Question 1</b>	<b>Supporting Question 2</b>	<b>Supporting Question 3</b>
What does innovation look like?	What does automobile innovation look like in Germany?	In what other areas is Germany a world leader in technology and innovation?
<b>Formative Performance Task</b>	<b>Formative Performance Task</b>	<b>Formative Performance Task</b>
Student groups will examine a timeline of the history of car technology to develop an understanding of innovation.	For this jigsaw activity, students will read or view the information on an assigned innovation, complete an informational chart, and share what they have learned with classmates.	Student groups will examine a map of Germany's technology and innovation hubs.
<b>Featured Sources</b>	<b>Featured Sources</b>	<b>Featured Sources</b>
<p><b>Source A:</b> Handout 4.4.1</p> <p><b>Source B:</b> The History of Car Technology</p>	<p><b>Source A:</b> Handout 4.4.2</p> <p><b>Source B:</b> <i>Fuel Cell Truck</i></p> <p><b>Source C:</b> <i>Mercedes-Benz F 015 Luxury in Motion: A Driving Experience of a Different Kind</i></p> <p><b>Source D:</b> <i>Synthetic eFuels</i></p> <p><b>Source E:</b> <i>The German History Scavenger Hunt: Part 3</i></p> <p><b>Source F:</b> <i>Volkswagen Sustainability</i></p>	<p><b>Source A:</b> Handout 4.4.3</p> <p><b>Source B:</b> <i>Technology and Innovation</i></p>
<b>Summative Performance Task</b>	<p><b>Argument:</b> 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><b>Extension:</b> Learn more about Adidas' environmentally friendly innovative ideas and new technologies.</p>	
<b>Taking Informed Action</b>	<p><b>Understand:</b> Plastic waste has become a worldwide problem.</p> <p><b>Assess:</b> Examine these nine innovations for recycling and replacing plastic.</p> <p><b>Act:</b> Determine ways your school could eliminate the use of plastic and share with your teacher and school administrators.</p>	

## ? COMPELLING QUESTION

- How are German companies leading the way in innovation?

### INQUIRY OVERVIEW

Students will learn about the concept of innovation and investigate German industries that are leaders in innovation.

### TEACHER BACKGROUND

Education is the backbone of Germany's technological innovation. According to The Federal Ministry of Education and Research, "the goal is for good ideas to be translated quickly into innovative products and services. This is because innovative solutions are the factors that drive our prosperity and support our quality of life."<sup>1</sup>

Germany abolished tuition fees for universities in 2014. Dorothee Stapelfeldt, a representative of the Social Democratic Party of Germany, summed it up as follows: "tuition fees are socially unjust. They particularly discourage young people who do not have a traditional academic family background from taking up studies. It is the core task of politics to ensure that young women and men can study with a high-quality standard, free of charge in Germany."<sup>2</sup> This has attracted more German as well as international students to attend university in Germany. *Deutsches Studentenwerk*, a German state-run nonprofit for student affairs, found that 11.1 percent of all students in Germany were international students in the 2019/2020 academic year. This put Germany in fourth place in the list of host countries and made it the top non-English-speaking host country for foreign students.<sup>3</sup> In comparison, in American universities the proportion of international students was 6 percent in 2020.<sup>4</sup>



According to the Global Innovation Index 2020, Germany was the ninth most innovative country globally. It is also ranked eighth for university–industry cooperation, and is home to ten of the world's 100 leading science and technology clusters (e.g., Cologne and Munich). The index places Germany as the world leader in patents by origin. The index also reveals that Germany is one of the countries with the highest spending on research and development. For example, in 2017, Germany allocated €800 million in funds to energy-efficient and renewable research. It also increased its spending by 45 percent on nonnuclear technology research to €6.4 billion between 2018 and 2022.<sup>5</sup>

The Federal Ministry for Economic Affairs and Energy also stresses the importance of diversity specifically in start-ups and research. "The number of self-employed persons with a migrant background has risen by 30% since 2005."<sup>6</sup> Also, although only one third of start-ups are founded by women, they account for 41 percent of the workforce.

1 Schoeman, R. (2016, May 5). *Why Is Germany A Powerhouse in Research and Innovation?* Culture Trip. <https://theculturetrip.com/europe/germany/articles/germany-technology-research-and-innovation/>.

2 Ibid.

3 Studentenwerk. (2020). Internationalisierung in Zahlen. <https://www.studentenwerke.de/de/content/internationalisierung-zahlen>.

4 Batalova, J, Israel, E. (2021, January 14). International Students United States 2020. Migration Policy. <https://www.migrationpolicy.org/article/international-students-united-states-2020>.

5 German Patent and Trade Mark Office. (2020). Global Innovation Index 2020. [https://www.dpma.de/english/our\\_office/publications/background/globalinnovationindex2020/index.html](https://www.dpma.de/english/our_office/publications/background/globalinnovationindex2020/index.html).

6 Federal Ministry for Economic Affairs and Energy. (2017). Start-ups: A Driving Force for Growth And Competition. <https://www.bmwi.de/Redaktion/EN/Dossier/start-ups.html>.

In Germany, innovators benefit from a vibrant business sector to bring innovations to market. The country's strong competitive performance can be further explained by very solid fundamentals, such as a stable macroeconomic environment and a healthy, well-educated, and highly skilled population.

 **TIME:** Two to three 45-minute classes

## INSTRUCTIONAL RESOURCES

- Car Technology Timeline (**Handout 4.4.1**)
- Automobile Innovation in Germany (**Handout 4.4.2**)
- German Technology and Innovation (**Handout 4.4.3**)
- Adidas. (n.d.). *Innovation*. Retrieved October 28, 2021, from <https://www.adidas-group.com/en/sustainability/products/sustainability-innovation/#/parley-ocean-plastic/>.
- Daimler. (2021, May 19). *Fuel Cell Truck*. Daimler. <https://www.daimler.com/innovation/drive-systems/hydrogen/start-of-testing-genh2-truck-prototype.html>.
- GCB. (2020, May 4). *Technology and Innovation*. [www.gcb.de/discover-germany/discover-german-expertise/technology-and-innovation.html](http://www.gcb.de/discover-germany/discover-german-expertise/technology-and-innovation.html).
- Jardine Motors Group. (n.d.). "The History of Car Technology." *Driving Seat*. Retrieved October 28, 2021, from [news.jardinemotors.co.uk/lifestyle/the-history-of-car-technology](http://news.jardinemotors.co.uk/lifestyle/the-history-of-car-technology).
- Mercedes-Benz. (2015, April 28). *Mercedes-Benz F 015 Luxury in Motion: A Driving Experience of a Different Kind*. YouTube. <https://youtu.be/IWB4xj7EILg>. (first 4:30 minutes only)
- Porsche. (2020, December 2). Porsche and Siemens Energy, with Partners, Advance Climate-Neutral eFuels Development. <https://newsroom.porsche.com/en/2020/company/porsche-siemens-energy-pilot-project-chil-e-research-development-synthetic-fuels-efuels-23021.html>.
- Sengupta, S. (2021, February 16). 9 Innovations for Recycling and Replacing Plastics. *Seventeen Goals Magazin*. <https://www.17goalsmagazin.de/en/9-innovations-to-up-cycle-plastic-waste/>.
- Transatlantic Outreach Program. (2020, April 24). *The German History Scavenger Hunt: Part 3*. YouTube. <https://www.youtube.com/watch?v=jBNEuqoWv8s&t=185s>. (1:57–2:45)
- Volkswagen Group. (2021). *Volkswagen Sustainability*. <https://www.volkswagenag.com/en/sustainability/environment/vehicle.html>.
- Wakefield High School. Concept Map (4-Square). Retrieved October 28, 2021, from <https://wakefield.apsva.us/literacy-initiative/vocabulary-resources/concept-map-4-square/>



## INTRODUCTORY QUESTION

Ask students to define the word *invention*. What is it? What makes something an invention? Ask students to name some inventions that impact their lives.

Next, write the following phrase on the board: "Build a better mousetrap..." Ask students what they think it means if the mousetrap is an invention. Explain that the process of building a better mousetrap is called innovation.\*

Other examples include:

- First telephone – smartphone
- Typewriter – computer word-processing program
- E-mail – social media

\*Teachers may wish to share the following history of this phrase and the many attempts to build a better mousetrap! ([https://en.wikipedia.org/wiki/Build\\_a\\_better\\_mousetrap,\\_and\\_the\\_world\\_will\\_beat\\_a\\_path\\_to\\_your\\_door](https://en.wikipedia.org/wiki/Build_a_better_mousetrap,_and_the_world_will_beat_a_path_to_your_door))

## ❓ SUPPORTING QUESTION 1

### What does innovation look like?

#### ► Formative Performance Task

Distribute **Handout 4.4.1** to small groups of students. The handout is a timeline of the history of car technology. Ask students to examine the timeline, answering the following questions.

- At what point did the *first* innovation of car technology take place? Why do you say this?
- Which innovation had the *most* impact on car safety?
- Which innovation had the *least* impact on car safety?
- Were you surprised by any innovations? If yes, which ones? Why?
- What is a future innovation you'd like to have in a car you own?

As a class, briefly discuss the questions. Ask students to create vocabulary squares to show they understand the difference between invention and innovation.

Teachers may wish to have students visit the website where the timeline is located to learn more about each innovation.

#### ► Resources

- Car Technology Timeline (**Handout 4.4.1**)
- Jardine Motors Group. (n.d.). "The History of Car Technology." Driving Seat. Retrieved October 28, 2021, from news.jardinemotors.co.uk/lifestyle/the-history-of-car-technology.
- Wakefield High School. Concept Map (4-Square). Retrieved October 28, 2021, from <https://wakefield.apsva.us/literacy-initiative/vocabulary-resources/concept-map-4-square/>

## ❓ SUPPORTING QUESTION 2

### What does automobile innovation look like in Germany?

#### ► Formative Performance Task

To introduce innovative technology in Germany, watch *The German History Scavenger Hunt: Part 3* (1:57–2:45).

For this jigsaw activity, divide the class into groups of four, which become their home group. Assign each group member to name an innovation from the following list:

- Hydrogen fuel-cell trucks
- All-electric commercial vehicles
- Synthetic efuels
- Autonomous driving vehicles (video, first 4:30 minutes only)

Regroup students with the same innovation together. This is the expert group. Using **Handout 4.4.2**, students in the expert group should read or view the information on the assigned innovation and complete the chart as a group.

Once the charts are completed, students should return to their home groups. Each person is responsible for sharing what they have learned about their innovation with the other members of the home group. As each innovation is shared, the home group could list the pros and cons of each.

#### ► Resources

- Automobile Innovation in Germany (**Handout 4.4.2**)

- Daimler. (2021, May 19). *Fuel Cell Truck*. Daimler. <https://www.daimler.com/innovation/drive-systems/hydrogen/start-of-testing-genh2-truck-prototype.html>.
- Mercedes-Benz. (2015, April 28). *Mercedes-Benz F 015 Luxury in Motion: A Driving Experience of a Different Kind*. YouTube. <https://youtu.be/IWB4xj7EILg>. (first 4:30 minutes only)
- Porsche. (2020, December 2). Porsche and Siemens Energy, with Partners, Advance Climate-Neutral eFuels Development. <https://newsroom.porsche.com/en/2020/company/porsche-siemens-energy-pilot-project-chil-e-research-development-synthetic-fuels-efuels-23021.html>.
- Transatlantic Outreach Program. (2020, April 24). *The German History Scavenger Hunt: Part 3*. YouTube. <https://www.youtube.com/watch?v=jBNEuqoWv8s&t=185s>.
- Volkswagen Group. (2021). *Volkswagen Sustainability*. <https://www.volkswagenag.com/en/sustainability/environment/vehicle.html>.

### 🔍 SUPPORTING QUESTION 3

#### *In what other areas is Germany a world leader in technology and innovation?*

##### ► Formative Performance Task

Distribute **Handout 4.4.3** to small groups of students. Ask each group to examine the map of Germany's technology and innovation hubs for the following:

- Which technology appears to be the most widespread?
- Which *Länder* have the largest number of information and communication facilities? Electrotechnology facilities?
- Do you notice a difference in the number of industries in the *Länder* in the west versus the east? Why might this be the case?

As a class, discuss what was found.

If time allows, teachers may want students to investigate specific areas of innovation and technology on the GCB website (GCB = German Convention Bureau). Clicking on one of the red links on the right side of the page opens up a web page with the specifics about an industry (e.g., Energy and the environment) and a map showing the numbers for each *Land*.

##### ► Resources

- German Technology and Innovation (**Handout 4.4.3**)
- GCB. (2020, May 4). *Technology and Innovation*. [www.gcb.de/discover-germany/discover-german-expertise/technology-and-innovation.html](http://www.gcb.de/discover-germany/discover-german-expertise/technology-and-innovation.html).

### ✅ SUMMATIVE PERFORMANCE TASK

#### *How are German companies leading the way in innovation?*

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

### ⊕ EXTENSION (OPTIONAL) TASK

Adidas is a German multinational corporation, founded and headquartered in Herzogenaurach, Germany, that designs and manufactures shoes, clothing, and accessories. It is the largest sportswear manufacturer in Europe, and the second largest in the world.

At Adidas, innovation is at the core of all its products. Learn more about the company's environmentally friendly innovative ideas and new technologies.

► **Resource**

- Adidas. (n.d.). *Innovation*. Retrieved October 28, 2021, from <https://www.adidas-group.com/en/sustainability/products/sustainability-innovation/#/parley-ocean-plastic/>.

 **TAKING INFORMED ACTION**

**Understand:** Plastic waste has become a worldwide problem.

**Assess:** Examine the 9 Innovations for Recycling and Replacing Plastics.

**Act:** Determine ways that your school could eliminate the use of plastic and share with your teacher and school administrators.

► **Resource**

- Sengupta, S. (2021, February 16). 9 Innovations for Recycling and Replacing Plastics. *Seventeen Goals Magazin*. <https://www.17goalsmagazin.de/en/9-innovations-to-up-cycle-plastic-waste/>.

**CONCEPTS LIST**

- Innovate
- Invention
- Technology
- Industry