



Electric Vehicles Toolkit

CHARGING FORWARD: ELECTRIC VEHICLE DEBATES

HIGH SCHOOL ENVIRONMENTAL SCIENCE / EARTH SCIENCE

For more information on Ignited, visit:
<https://ignitededucation.org>

For more information on RAFT visit:
<https://www.raft.net>

For more information on Acterra visit:
<https://www.acterra.org>





Charging Forward: Electric Vehicle Debates

What do we need to consider as a society as electric vehicles gain traction?

Lesson Overview	Career Highlight
Students will present scientific arguments on various topics related to electric vehicles in the form of debates with the goal of becoming more aware of some of the issues related to the adoption of electric vehicles.	Environmental Lawyer

STEM Course Connections	21st Century Skills	CTE Alignment
High School Earth/Environmental Science	Communication Collaboration	Environmental Engineering

Engineering Activity	
Science and Engineering Practice #4 & 5	Students will research a scientific argument and present it in a debate.

Materials
<ul style="list-style-type: none">• Student Handout• Device with internet access

Essential Questions
<ol style="list-style-type: none">1. What hurdles, challenges, and misconceptions does our society need to address as electric vehicles become more prevalent?2. Considering the pros and cons of these dilemmas, what are potential resolutions?3. How can scientific argumentation help us become more aware of scientific developments?

Mission Prep
Engage (10 mins) <ol style="list-style-type: none">1. Play PBS Newshour’s “Why Electric Cars Aren’t All Over the Place” video segment.2. Have students respond to the following questions in their student handout:<ol style="list-style-type: none">a. What are three concerns that the interviewer, William Brangham, brings up regarding electric vehicles?b. Pick one of the three concerns that you shared. What is the dilemma? How can it be overcome?

Explore (10 mins)

1. Introduce Debate
 - a. Why debate? Explain how in science there are many different perspectives on the same dilemma; whether it is because they are different stakeholders, have different pieces of data in front of them, or interpret the data differently, developments in science require dialogue and scientific debate.
 - b. Skills needed to debate? Understanding and application of scientific concept, collection and analysis of evidence, awareness and openness to alternative explanations, clear and persuasive communication of ideas
 - c. How to debate? The debate format that will be used for our electric vehicle debates is:
 - i. Introductory Statements (2 min)
 - ii. Main Arguments (6 min)
 - iii. Rebuttal (4 min)
 - iv. Closing Statements (2 min)
 - d. Who will debate?
 - i. Debate teams will be composed of 3 - 6 classmates.
 - ii. Everyone will participate in at least one component of the debate
 - iii. Explain how you will set up the debate teams. Will students pick which topic they feel passionate about? Will students pick which side they will debate (for/against)

Launch

Explain (35 mins)

1. Model Debate Process
 - a. Using the first concern mentioned in the interview, carbon emissions, model for the class the research steps:
 - i. Define the issue
 - ii. Determine the stakeholders
 - iii. Identify the pros and cons
 - iv. Brainstorm potential resolutions
 - b. Walk through the debate procedure
This can be done by asking for students to participate in the modeling process as mock debaters if it is helpful or simply walking through as a whole class
 - i. Opening Statement: For Electric Vehicles (2 min)
 - ii. Opening Statement: Against Electric Vehicles (2 min)
 - iii. Main Arguments: For Electric Vehicles (6 min)
 - iv. Main Arguments: Against Electric Vehicles (6 min)
 - v. Rebuttal: For Electric Vehicles (4 min)
 - vi. Rebuttal: Against Electric Vehicles (4 min)
 - vii. Closing Statements: For Electric Vehicles (2 min)
 - viii. Closing Statements: Against Electric Vehicles (2 min)
 - c. Debrief Debate Process
 - i. Field clarification questions from class about debate format and process
 - ii. Explain that they will now complete these steps for their assigned debate topic

Elaborate (45 mins)

1. Establish Debate Teams
 - a. Share with students the electric vehicle debate topics (see table in [student handout](#))

Topic	What is the conflict?
Equitable Access	For lower income households, how will they have the tools to adapt to EVs?
Recycling of EV batteries	How are EV batteries recycled? What regulations need to be in place? Who is responsible for this process?
Mining for battery materials	How do we mine? (pollution info) Worker safety regulations
Resource depletion	Will there be enough resources to keep creating EV batteries? How does this impact our environment?
Mineral assets	What countries have these minerals? How are they being protected/supported?

- b. If assigning topic/side randomly: assign students to teams of 3-6 and give them their topic/side.
- c. If allowing students to select topic: give them time to browse the debate topics and make selection

2. Debate Topic Research

Using the [student handout](#) as a guide, students will research their debate topic and record their information in the student handout.

During this process, they should define the issue, determine the stakeholders, identify the pros and cons, and brainstorm potential resolutions.

3. Plan Debate Argument

- a. In their debate teams, students should plan what their introductory statement, three main arguments, potential rebuttals, and closing will be.
- b. Students should identify roles so that each person in the team is participating in one component of the debate.
- c. Students should record their plan in the student handout.

3. Practice Debate

- a. Students should practice delivering their components in the allotted time frame.
- b. Allow time for feedback from team and adjustment to delivery

Exploration

Evaluate (30 - 150 mins)

1. Debate

- a. Set up: Place two tables facing one another in the center of the room for the two debating teams. Have additional seating surrounding the tables for audience members. Have a timer displayed so that it is visible to both teams (projected on board).
- b. Welcome. Invite teams to sit at tables. Invite the rest of class to find seats in the audience. Review the debate rules (all team members must speak, speak only for allotted time, only speak when it is your turn/no interruptions, keep respectful tone)

- c. Start debate with opening statements from both sides (for and then against), followed by main arguments (for and then against), rebuttals (for and then against), and finish with closing statements (for and then against).

2. Debrief

After individual debates, or after all debates have concluded, hold a debrief session for students [to reflect](#) on:

- a. What is your current opinion about the hurdles, challenges, and misconceptions surrounding electric vehicles? What are the pros and cons of these?
- b. How has this debate process impacted your awareness and/or confidence of the topics?
- c. How was the experience different as a presenter? As an audience member?
- d. Would you want to pursue a career that uses these skills? (For students that are looking for more in depth information, here is [a panel discussion](#) hosted by Drexel University of a range of environmental lawyers talking about what they do ... start at 7 minute mark of video through the 20 minute mark)

Extend (optional)

1. Position Paper

Now that students have debated, they can write a position paper on their assigned topic where they can choose which side to support. The paper should follow a similar structure to the debate. Here is a suggested position paper format:

- a. Introduction
 - i. Hook
 - ii. Define issue
 - iii. Position (for/against)
- b. Counterargument
 - i. State opposing view
 - ii. Provide evidence for opposing view
- c. Argument - Reason 1
 - i. State first reason
 - ii. Provide evidence
- d. Argument - Reason 2
 - i. State second reason
 - ii. Provide evidence
- e. Argument - Reason 3
 - i. State third reason
 - ii. Provide evidence
- f. Conclusion
 - i. Restate position
 - ii. Summarize three main reasons to support
 - iii. Final thoughts

- HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
- HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.
- HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

CTE Alignment

- D2.3 Choose between alternate solutions in solving a problem and be able to justify choices in determining a solution.
- D2.4 Understand the process of developing multiple details into a single solution.
- D2.5 Translate word problems into mathematical statements when appropriate.
- D12.3 Compare costs of alternate/renewable energy sources, systems, and appliances and traditional energy sources, systems, and appliances.

Resources

- Alternative Fuels Data Center. (2015, May 30). *Alternative Fuels Data Center: Yellowstone Park Recycles Vehicle Batteries for Solar Power*. Afdc.energy.gov. <https://afdc.energy.gov/case/2163>
- Backhaus, R. (2021). Battery Raw Materials - Where from and Where to? *ATZ Worldwide*, 123(9), 8–13. <https://doi.org/10.1007/s38311-021-0715-5>
- Bogden, M. (2023, July 12). *How to Host a Debate in Your Science Classroom*. Vivify STEM. <https://www.vivifystem.com/blog/2023/7/12/unleashing-the-power-of-classroom-science-debates>
- Carey, N., & Lienert, P. (2022, November 15). EV battery makers race to develop cheaper cell materials, skirting China. *Reuters*. <https://www.reuters.com/business/autos-transportation/ev-battery-makers-race-develop-cheaper-cell-materials-skirting-china-2022-11-15/>
- Cart, J. (2023, March 1). Jump-starting electric car batteries: Will supply problems stall California’s mandate? *CalMatters*. <https://calmatters.org/environment/2023/03/electric-car-batteries-challenges/>
- Centers for Disease Control and Prevention. (2023, May 1). *CDC - Mining Project - Lithium-Ion Battery Hazards - NIOSH*. Centers for Disease Control and Prevention. https://www.cdc.gov/niosh/mining/researchprogram/projects/project_Lithium-IonBatteryHazards.html
- Chao, J., & Berkeley Lab. (2021). *How to Make Lithium-ion Batteries Invincible by Berkeley Lab*. Exposure. <https://photostories.lbl.gov/how-to-make-lithiumion-batteries-invincible>

- Congressional Research Service. (2019, August 29). *Critical Minerals in Electric Vehicle Batteries*. Congress.gov. <https://crsreports.congress.gov>
- Crawford, I. (2022, February 16). *How much CO2 is emitted by manufacturing batteries?* MIT Climate Portal. <https://climate.mit.edu/ask-mit/how-much-co2-emitted-manufacturing-batteries>
- Cumps, A. (2021). *Cumps_ScienceCurriculum21.pdf*. Google Docs. https://drive.google.com/file/d/1TknsN_u51vIkRWUusnfba010n0pQEBZ-6/view
- Drexel University Thomas R. Kline School of Law. (2021, April 7). *Careers in Environmental Law*. Wwww.youtube.com. <https://youtu.be/r0TsA5SIwK0>
- Dunn, J. (2022, November 15). *Are There Enough Materials to Manufacture All the Electric Vehicles Needed? The Equation*. <https://blog.ucsusa.org/jessica-dunn/are-there-enough-materials-to-manufacture-all-the-electric-vehicles-needed/#:~:text=The%20short%20answer%20is%20yes>
- Egan, T. (2023, March 10). *Where do electric vehicle batteries come from?* EnergyX | Energy Exploration Technologies, Inc. <https://energyx.com/blog/where-do-electric-vehicle-ev-batteries-come-from/#:~:text=Source%20of%20EV%20Batteries&text=Half%20of%20the%20world%27s%20cobalt>
- EVBox. (2023, May 12). *How long do electric car batteries last? | EVBox*. Blog.evbox.com. <https://blog.evbox.com/ev-battery-longevity#:~:text=According%20to%20current%20industry%20expectations>
- Graham JD and Brungard E (2022) *Affordable Electric Vehicles: Their Role in Meeting the U.S. Contribution to the Paris Climate Goals*. Front. Environ. Sci. 10:962942. doi: 10.3389/fenvs.2022.962942
- Hardman, S., Fleming, K. L., Khare, E., & Ramadan, M. M. (2021, August 20). *A perspective on equity in the transition to electric vehicles*. MIT Science Policy Review. <https://sciencepolicyreview.org/2021/08/equity-transition-electric-vehicles/>
- Korn, M., & A.B.C. News. (2023, February 12). *Electric vehicle batteries require precious minerals. That old cellphone may be the solution*. ABC News. <https://abcnews.go.com/Business/electric-vehicle-batteries-require-precious-minerals-cellphone-solution/story?id=96977978>
- Lohan, T. (2021, March 10). *Will the Race for Electric Vehicles Endanger the Earth's Most Sensitive Ecosystem? • The Revelator*. The Revelator. <https://therevelator.org/ev-batteries-seabed-mining/>
- National Grid. (2022, July 15). *What happens to old electric car batteries? | National Grid Group*. Wwww.nationalgrid.com. <https://www.nationalgrid.com/stories/journey-to-net-zero-stories/what-happens-old-electric-car-batteries#:~:text=Yes%2C%20when%20EV%20batteries%20reach>

- Newcomb, D. (2023, May 10). *Apartment EV Charging: How Renters Can Get Juice*. MotorTrend. <https://www.motortrend.com/features/apartment-ev-charging-renters-rights/>
- Ohnsman, A. (2022, September 19). *Dig This: The Shift To EVs Requires A Massive Expansion Of Battery Metal Mining*. Forbes. <https://www.forbes.com/sites/alanohnsman/2022/09/19/dig-this-the-shift-to-evs-requires-a-massive-expansion-of-battery-metal-mining/?sh=9821b6829636>
- Otis, J. (2022, September 24). In Chile's desert lie vast reserves of lithium — key for electric car batteries. *NPR*. <https://www.npr.org/2022/09/24/1123564599/chile-lithium-mining-atacama-desert>
- PBS NewsHour. (2023, February 23). *Why Electric Cars Aren't All over the Place | PBS NewsHour*. PBS LearningMedia. <https://ca.pbslearningmedia.org/resource/why-electric-cars-arent-all-over-the-place-video/pbs-newshour/>
- Powell, L., & Carioti, R. (2023, February 13). *How lithium gets from the earth into your electric car*. Washington Post. <https://www.washingtonpost.com/business/interactive/2023/how-is-lithium-mined/>
- Sandalow, B. (2023, March 6). *The Challenges of Mining for Electric-Vehicle Batteries*. Northwestern Engineering. <https://www.mccormick.northwestern.edu/news/articles/2023/03/the-challenges-of-mining-for-electric-vehicle-batteries/>
- Slanger, D. (2023, May 5). *The EV Battery Supply Chain Explained*. RMI. <https://rmi.org/the-ev-battery-supply-chain-explained/#:~:text=China%20currently%20dominates%20the%20supply>
- Steckelberg, A., Dormido, H., Mellen, R., Rich, S., & Brown, C. (2023, April 27). *The underbelly of electric vehicles*. Washington Post. <https://www.washingtonpost.com/world/interactive/2023/electric-car-batteries-geography/>
- U.S. Department of Transportation. (2023, May 5). *Equity Considerations in EV Infrastructure Planning | US Department of Transportation*. [www.transportation.gov](https://www.transportation.gov/rural/ev/toolkit/ev-infrastructure-planning/equity-considerations). <https://www.transportation.gov/rural/ev/toolkit/ev-infrastructure-planning/equity-considerations>
- US Department Of Energy. (2019). *Alternative Fuels Data Center: Maintenance and Safety of Hybrid and Plug-In Electric Vehicles*. Energy.gov. https://afdc.energy.gov/vehicles/electric_maintenance.html
- Vermes, J. (2023, February 27). *As EV batteries consume more lithium, report warns against increased mining of it*. CBC. <https://www.cbc.ca/radio/whatonearth/lithium-mining-report-transit-1.6755418>
- Wall Street Journal. (2023, June 13). *From Mine to Battery: Indonesian Nickel Drives the World's EV Market*. WSJ. <https://www.wsj.com/video/series/in-depth-features/from-mine-to-battery-indonesian-nickel-drives-the-worlds-ev-market/AE4FD438-DEFB-4490-BCA9-546AECD44AF8>

