

### How should the United States deal with nuclear waste?

#### Energy Literacy Essential Principle 1: Energy is a physical quantity that follows precise natural laws.

##### C3 Framework for Social Studies Focus Indicators

- D1:** Explain points of agreement and disagreement experts have about interpretations and applications of disciplinary concepts and ideas associated with a compelling question. (D1.2.9-12)
- D2:** Use appropriate deliberative processes in multiple settings. (D2.Civ.9.9-12)  
Distinguish between long-term causes and triggering events in developing a historical argument. (D2.His.15.9-12)
- D3:** Gather relevant information from multiple sources representing a wide range of views while using the origin, authority, structure, context, and corroborative value of the sources to guide the selection. (D3.1.9-12)
- D4:** Construct argument using precise and knowledgeable claims, with evidence from multiple sources, while acknowledging counterclaims and evidentiary weaknesses. (D4.1.9-12)

**Grade Level:** 9-12. **Time Required:** 3-4 class periods.

##### Connection to Energy Literacy

Chemical and nuclear reactions involve the transfer and transformation of energy (Energy Literacy 1.6). In this activity, students organize information about the energy released by nuclear reactions and the historical development of nuclear power. They use this information to help them debate the merits of the different methods that can be used to store nuclear waste from the production of nuclear energy.

##### Activity Outline

- Show images of nuclear reactors or cooling towers to students. Ask them what they know about nuclear power and the harnessing of nuclear energy to generate electricity. Gauge their background knowledge about some of the controversies surrounding nuclear energy.
- Have students read *What is Nuclear Energy* by the United States Nuclear Regulatory Commission and *Nuclear Energy: Background* by the American Geosciences Institute. Ask them to describe the processes involved in the release of nuclear energy and the transformation of that energy into electricity in a nuclear power plant. You may want to have students demonstrate their understanding by drawing diagrams that illustrate the energy conversions that occur in a nuclear power plant.
- Have students read *US Nuclear Power Plants Posted Record High Efficiency in 2014* by Penn Energy. Discuss with them the importance of nuclear energy for the generation of electricity in the United States.

- As a class or individually, have students read the Preface and Introduction to the US Department of Energy report *The History of Nuclear Energy*. “Jigsaw” the remaining text (pages 4-12) by assigning passages to individual students or groups. Tell students that, for their passages, they should identify and record the key events in the development of nuclear power. When done, have students present their findings.
- Have students read the Guardian article *US Sailors Prepare for Fresh Legal Challenge Over Fukushima Radiation*, the SEA article *French Nuclear Testing in Polynesia*, and the NPR article *Fukushima, Three Mile Island, Chernobyl: Putting It All in Perspective*. Discuss, with students, the impacts of nuclear research and the dangers of nuclear power.
- Have students read the USNRC *Spent Fuel FAQ* page, which includes information about the use of spent fuel pools for the disposal of waste from nuclear power plants in the United States. Next, have them read the World Nuclear Association’s *Storage and Disposal Options* page which provides descriptions of a range of methods for storing and disposing of nuclear waste.
- Organize students into groups. Ask each group to select one or more of the disposal options described by the World Nuclear Association. Alternatively, you may want to assign options to groups. Tell groups that they will be participating in a debate in which they will argue that their disposal method is the best option for nuclear waste in the United States.
- Allow students time to develop their arguments. You may want to encourage them to use other sources of information. Be sure to remind them to evaluate those sources and consider any biases from the authors. Additionally, you may want to have students write an essay or a position paper in which they describe their nuclear waste disposal method and provide evidence for why it is the best option for nuclear waste disposal.
- Hold a class debate in which groups present their nuclear waste disposal options and discuss the advantages and disadvantages of the different methods.
- Have students engage in oral or written post-debate reflection regarding their performances in the debate and what they feel should be done about the issue.
- As an extension, you may want to hold another debate in which students argue for and against nuclear energy as a resource for generating electricity.

## Suggested resources include:

- United States Nuclear Regulatory Commission “What is Nuclear Energy”  
<http://www.nrc.gov/reading-rm/basic-ref/students.html>
- American Geosciences Institute “Nuclear Energy: Background”  
<http://www.agiweb.org/education/energy/nuc/index.html>
- Penn Energy “US Nuclear Power Plants Posted Record High Efficiency in 2014”  
<http://www.pennenergy.com/articles/pennenergy/2015/01/us-nuclear-power-plants-posted-record-high-efficiency-in-2014.html>
- US Department of Energy “The History of Nuclear Energy” [http://www.energy.gov/sites/prod/files/The%20History%20of%20Nuclear%20Energy\\_0.pdf](http://www.energy.gov/sites/prod/files/The%20History%20of%20Nuclear%20Energy_0.pdf)

- The Guardian “US Sailors Prepare for Fresh Legal Challenge Over Fukushima Radiation” <http://www.theguardian.com/environment/2014/aug/20/us-navy-sailors-legal-challenge-fukushima-radiation-tepco>
- SEA Semester “French Nuclear Testing in Polynesia” [http://www.sea.edu/spice\\_atlas/nuclear\\_testing\\_atlas/french\\_nuclear\\_testing\\_in\\_polynesia](http://www.sea.edu/spice_atlas/nuclear_testing_atlas/french_nuclear_testing_in_polynesia)
- NPR “Fukushima, Three Mile Island, Chernobyl: Putting It All in Perspective” <http://www.npr.org/2011/03/17/134568383/japan-three-mile-island-chernobyl-putting-it-all-in-perspective>
- United States Nuclear Regulatory Commission “Spent Fuel FAQ” <http://www.nrc.gov/waste/spent-fuel-storage/faqs.html> World Nuclear Association “Storage and Disposal Options” <http://www.world-nuclear.org/info/Nuclear-Fuel-Cycle/Nuclear-Wastes/Appendices/Radioactive-Waste-Management-Appendix-2--Storage-and-Disposal-Options/#AboveGrdStorage>