

Spotlight on Photovoltaics & Fuel Cells

(A Web-based Study & Comparison)

Suggested Grade Level 9-12

Standard Statements

- 3.1.10 A Discriminate among the concepts of systems, subsystems, feedback and control in solving technological problems.
- 3.2.10 B Apply process knowledge and organize scientific and technological phenomena in varied ways.
- 3.4.12 A Apply concepts about the structure and properties of matter.
- 3.4.12 B Apply and analyze energy sources and conversions and their relationship to heat and temperature.
- 3.8.12 A Synthesize and evaluate the interactions and constraints of science and technology on society.
- 3.8.10 C Evaluate the possibilities, consequences, and impacts of scientific and technological solutions.
- 4.2.12 A Analyze the use of renewable and nonrenewable resources.

Content Objectives

Students will know that

- 1. A fuel cell is an electrolytic cell.
- 2. The four main parts of a fuel cell are the anode, catalyst, cathode, and electrolyte.
- 3. A fuel cell uses hydrogen and oxygen to produce an electrical current.
- 4. The main parts of a photovoltaic cell are the n-layer, p-layer, covers and junction.
- 5. A photovoltaic cells converts sunlight into electricity.
- 6. The flow of electrons creates a direct electric current in both fuel cells and photovoltaic cells. (DC voltage)
- 7. Scientific research on fuel cells and photovoltaic cells has been heavily influenced over the years by societal and economic factors.
- 8. There are both similarities and difference with the technology behind fuel cells and photovoltaics.

Process Objectives

Students will be able to

- 1. Describe how energy is created from the flow of electrons.
- 2. Compare and contrast fuel cells and photovoltaics.
- 3. Generate ideas about why these technologies can be considered clean energy sources.

Assessment Strategies

- 1. Completion of the entire student handout.
- 2. Class discussions on material and web simulations.

Materials

Per class:

- Student computers with Internet access
- Teacher computer
- Projection equipment
- Student handouts – one per student
- Images of photovoltaic layers and fuel cells (Teacher Notes)
- Chemistry model kits or toothpicks and gum drops

Multimedia Resources

- PowerPoint presentation, “PV Presentation FSEC”
- QuickTime movie, Photovoltaics (pv4) (1:11).
- Websites:
 - <http://www.greenspec.co.uk/html/design/materials/pvcells.html>
 - <http://www.pbs.org/newshour/science/hydrogen/images/interactive.swf>
 - <http://www.dsireusa.org/>

Procedures

Part 1

(1, 50-min Class Period)

1. Show students photos of a Photovoltaic (PV) array and a fuel cell and ask them what they know about the chemistry that makes each technology produce electricity.
 - a. PV array: http://www1.eere.energy.gov/solar/pv_use.html
 - b. Fuel cell: <http://www.nrel.gov/data/pix/Jpegs/12508.jpg>
2. Review the chemistry terms: electron, photon, cathode, and anode.
3. Have the students work in pairs to create the following models: hydrogen, oxygen, water, silicon. Students may use molecular modeling kits if available, pipe cleaners and gum drops or drawings to model the molecules.
4. Give a short lecture using the “PV Presentation FSEC.ppt.” Students will need to be able to make a general comparison between a PV system and a fossil-fueled one in a discussion at the end of the section. The “PV Presentation FSEC” content may be edited to suit the needs and skills of your students.
5. Discuss the questions on the last slide of the presentation as a class.

Part 2

(1, 50-min Class Period)

1. Have the students watch the web simulation on fuel cells at:
<http://www.pbs.org/newshour/science/hydrogen/images/interactive.swf>
After viewing the simulation on fuel cells, have the students spend a few minutes working in groups to fill out the differences and similarities charts on their student handout.
2. Have the students watch and take notes on the following simulations on a photovoltaic cell at their computer:
 - QuickTime movie on how photovoltaics work: Photovoltaics (pv4) (1:11)
 - <http://www.greenspec.co.uk/html/design/materials/pvcells.html>
 - http://eagle.chimacum.wednet.edu/middle/jss/Course_SolarPanel.htm
3. Have the students fill in the schematic of the n-layer, p-layer and junction on the student handout and explain the chemistry behind how they function.

4. Invite students to share what they think are the differences between photovoltaic and fuel cells. Record the student responses on the board, or assign a student to this task.

Part 3

(1, 50-min Class Period)

1. Review how both the fuel cell and photovoltaic function to reinforce the differences in the chemistry between the two systems.
2. Ask the students to explain why and how both systems produce electricity.
3. Review and discuss how electron flow creates a current.
4. Review how both the fuel cell and photovoltaic function to reinforce the differences in the chemistry between the two systems using the diagrams of the photovoltaic and the fuel cell provided in the Teacher Notes or multimedia links provided on the E-21 website.
5. For homework have the students find a source that awards either a tax incentive or grant for using renewable energy. Have them write a paragraph about how their family might benefit from such an award. A great site for students to refer to is: <http://www.dsireusa.org/>.