

Cost-Effective Solar Cells

Lesson #9: Solar Cell Manufacturing Field Trip and/or Guest Speaker

AUTHOR

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DESCRIPTION

This lesson is designed to be completed in two 80-minute sections. The teacher will facilitate a field trip to a nearby silicon manufacturing facility, solar panel manufacturing facility, or other semiconductor facility. These facilities often require long advance notice and time is needed to work through school district field trip logistics. The teacher will also facilitate a solar panel, semiconductor, chemist, metallurgist, or semiconductor guest speaker in the classroom. The intent of the trip and guest speaker is to expose Chemistry students to manufacturing techniques and career opportunities in the local area. The trip or guest speaker can occur anywhere within the unit, but ideally takes place after students have experimented with solar cells themselves and before constructing their own unique solar cells.

- *Day 1: Local field trip: Silicon producers, Semiconductor companies, Photovoltaic companies, [State-by-state interactive map](#)*
- *Day 2: Guest speaker (see resources below)*

GRADE LEVEL(S)

9, 10, 11, or 12

SUBJECT AREA(S)

Chemistry, Physics, Solar Panels, Solar Cells, Power, Current, Voltage, Electricity Generation

ACTIVITY LENGTH

2 days X 80 minutes

LEARNING GOAL(S)

1. Students will visit a solar cell or silicon manufacturing facility and/or engage with guest speakers.
2. Students will learn more detailed solar cell principles and manufacturing techniques involved in solar [cell construction](#).

CONTENT BACKGROUND

STUDENT BACKGROUND

- Students participating in this lesson should be familiar with basic solar cell operation and should be prepared to ask questions about solar cells or careers involved with solar cell research, design, manufacturing, or distribution.

EDUCATOR BACKGROUND

- N/A

MATERIALS NEEDED

HANDOUTS/PAPER MATERIALS

- Required school paperwork & organization for field trips and/or guest speakers

CLASSROOM SUPPLIES

- N/A

ACTIVITY SUPPLIES (PER GROUP OF 3-4 STUDENTS)

- N/A

LESSON PROGRESSION

PLANNING AND PREP

This lesson aims to connect students with solar cell or solar panel related professionals. The preparation is divided into two parts:

1. Finding and contacting STEM partners or organizations

Silicon producers:

This Wikipedia page lists the silicon producers in the United States and beyond. Check the list for producers near your school. Silicon can be an expensive route for solar cell production, but the growth process can be fascinating for students and can connect well with lessons on crystal structure.

https://en.wikipedia.org/wiki/List_of_silicon_producers

Semi-conductor companies:

The semi-conductor companies can range widely in scope—from telecommunications, to computing, GPS, home electronics, and photovoltaics. Great science and materials content can be obtained from the research and development divisions of these companies.

https://en.wikipedia.org/wiki/Semiconductor_industry

Photovoltaic companies:

These are the companies who design, assemble, sell, distribute, and/or install photovoltaic arrays. Knowledge of solar cell chemistry can vary within these companies, but great career opportunities can be highlighted.

https://en.wikipedia.org/wiki/List_of_photovoltaics_companies

Interactive state-by-state map:

This site is an excellent resource for state-by-state solar energy data (total wattage, number of installations, state policies, etc.). On each state page, you can navigate an interactive map to find solar manufacturers, installers, and other companies nearest to your school.

<https://www.seia.org/states-map>

2. Organizing a field trip

Field trips in most districts typically require the following steps:

1. Permission from administration to pursue the field trip
2. District authorization for the trip (4-8 weeks in advance)
 - i. Curricular goals
 - ii. Number of students/chaperones
 - iii. Destination / Maps
 - iv. Date and times
 - v. Transportation plan
3. Collection of field trip forms and any fees
 - i. Student / Parent letter
 - ii. Field Trip permission slip
 - iii. Associated medical authorization forms
 - iv. Chaperone / Volunteer forms
 - v. Payment collection & receipts (if necessary)

- vi. Cafeteria / sack lunch orders (if necessary)
- 4. Field Trip Day:
 - i. Transportation confirmation
 - ii. Communication / contact information with school and chaperones
 - iii. Chaperone / student assigned groups
 - iv. Attendance rosters / check-in sheets
 - v. First-aid kits / medications
 - vi. Map of destination

3. Guest Speakers

Guest speakers can range from parents to professionals who work nearby. Typically the planning and organization is much less complex than field trip planning and can be very rewarding. Guest speakers may require the following steps:

1. Permission from administration
2. Guest speaker form
3. Volunteer clearance (depending on the level of interaction with students)
4. ***Independent contractor bid, tax information, and agreement (if the guest speaker needs to be paid—rare***)
5. Guest check-in and parking

LESSON SEQUENCE

Pre-visit:

1. **(5-15 minutes)**. Introduce the field trip or guest speaker opportunity to students and parents.
 - Student & Parent letter
 - Permission slips and fee information
2. **(5-10 minutes)**. Have the students generate their own questions in advance of the trip or guest speaker. Spend time introduce the company information or guest speaker background and ask students to research their work in advance.
3. **(Ongoing)**. Collect any required forms or fees in advance
4. **(Custom)**. Pre-teach any confusing concepts the students might encounter on the trip or with the guest speaker

During the visit:

1. **(5 minutes)**. Arrange students into any groups or seating arrangements

2. **(Ongoing)**. Encourage student questions through modeling or prompting
3. **(Concluding)**. Have students thank their hosts or guest speaker for the visit.

After the visit:

1. **(15-25 minutes)**. Have students share their highlights from the visit. This can be through several formats:
 - **Socratic Seminar (See Lesson 1)**
 - **Survey / Questionnaire**
 - **Individual reflection**
2. **(15-25 minutes)**. Connect any observations back to solar cell design, construction, and/or testing.

ASSESSMENT AND EXTENSIONS

FORMATIVE ASSESSMENT

- **NGSS SEP8**
Obtaining, Analyzing, and Communicating Information
 - Gather, read, and evaluate scientific and/or technical information from multiple authoritative sources, assessing the evidence and usefulness of each source.

SUMMATIVE ASSESSMENT

Students can submit reflections on the visit/speaker and summarize learning and additional points of inquiry related to the development of their own solar cell designs.

LESSON EXTENSIONS

A second seminar works well after Lesson #9 in the unit, when the students are beginning their research into their own solar cell designs. The driving question for the seminar can be:

What new solar cell technologies are being implemented?

Because the solar cell technology is rapidly changing, current event articles are highly suggested. Some possible topics in 2019 included:

- Perovskite nanocrystals
- Organic Photovoltaic systems (OPVs)
- Cadmium-Telluride solar cells
- Thin film solar cells
- Wearable solar cells
- Graphene nanotubes
- CZTS solar cells