



Outdoors

***Note:** sections of the lesson plan template marked with * are optional, but may be useful for your planning.

Making a battery out of soil	
Grade level	1-8
Standards (NGSS)	4-PS3-4
Learning Objectives (Goals)	<p>Students will be able to describe how chemical energy is transformed from light energy by plants and subsequently stored in soils.</p> <p>Students will experimentally demonstrate how the chemical energy stored in soils can be transformed into useful forms of energy (i.e., electricity to power LED lights!).</p>
Duration	1.5 hours
# students	≤32 students, in groups of 4.
Materials	Per group of 4 students: 6 plastic cups or an ice cube tray, soil (can bring one large bag of gardening soil to split amongst all the groups), water, distilled white vinegar, 5x ~5" pieces of thin copper wire, 5 galvanized steel (zinc) screws, 3 LED pin lights.
Location	In a classroom or anywhere outside as long as the students have tables to work on.
Logistics	The students' clothes will likely get dirty throughout the course of the experiment. The dirt can be easily and fully removed by washing the clothing, but students should be advised ahead of time to wear clothing they don't mind getting dirty.
Accessibility & safety awareness	GO-Outdoors volunteers, teacher, or students can assist students with motor disabilities. The voltage generated from the soil battery circuit is small enough to not present a danger to the students.
GO-Outdoors Missions	GO-Outdoors' mission is to increase K-12 students' exposure and access to the geosciences field through active learning strategies.
Lesson activities	

***Note: an accompanying PowerPoint presentation can be downloaded to provide visual support to all of the following background & instructions.**

[15 min]: **Engage** students by asking questions to get them thinking about energy and soils:

- What is energy? (A: the ability to do work)
- What are some different types of energy? (A: thermal, radiant, light, chemical, nuclear, electrical, gravitational, mechanical)
- What kind of energy do plants use, and what do they convert this energy to? (A: plants convert light energy into chemical energy)
 - What is this process called? (A: photosynthesis)
- What is soil? (A: decomposing organic matter containing positively and negatively charged ions, including electrons)

[1 min]: Tell students that today, we will use chemical energy stored in soils to make electricity and light energy. This is a soil battery!

[5 min]: Articulate instructions to students (either write instructions on whiteboard or show PowerPoint slide with instructions):

1. Mix soil in a cup with water and vinegar until soil is wet. Repeat to make 6 cups of wet soil arranged in a two-by-three grid.
2. Wrap a piece of copper wire twice around a metal screw.
3. Insert the screw in the soil of cup #1 (which cup is assigned #1 is arbitrary), and the accompanying copper wire into the soil in the next cup (cup #2).
4. Insert the next screw in cup #2 (containing the submerged copper wire), and insert the accompanying copper wire into the next cup (cup #3). Repeat until there are 5 screws inserted in cups #1-5, and 5 connecting wires submerged in cups #2-6. Do not close the circuit yet (i.e., do not connect cup #1 & 6 with a copper wire).
5. Insert an LED pin light so the ends are submerged in cups #1 & 6. *(This closing of the circuit will start the flow of electricity, which will power the LED light. The students should see the light illuminated!)*

[40 min]: Have students come up with a hypothesis about what will happen when they connect the circuit with the LED light. Allow students (in groups of 4) to set up their soil batteries and explore/have fun! Each group should spend some time playing with their circuit to identify what configurations enable the light to successfully turn on and come up with explanations for their observations. Some ideas students can test:

- What is the minimum number of cups in a circuit that will allow the LED light to illuminate?

- Where are all the places (in combinations of two cups) that the LED pin light can be placed such that the light still illuminates?
- Do the legs of the LED pin lights have to span different cups, or can both legs be inserted into one cup?
- Is there a limit to the number of LED pin lights their soil battery can support?

[10 min]: Have students clean up their stations. GO-Outdoors volunteers should collect the screws, copper wires, ice cube trays (if used), and LED pin lights for re-use in the future.

[15 min]: **Engage + explain:**

- Begin by asking students some questions about batteries:
 - Where do we find batteries? (A: everywhere)
 - How does a battery work? (This concept is a bit tricky; you may need to explain this to students. A: When a battery is not in use, chemical energy is stored in a battery. When a battery is connected to a device, electricity is generated by the movement of electrons).
- Have students **explain** how a soil battery works, connecting the definition of a battery to their experiment/observations. Have students use the following words in their explanation: chemical energy, electricity, storage/stored, soil, electrons. (A: our soil battery converts stored chemical energy into electricity when we build a path for electrons to flow).
- Have students **explain**/revisit where this energy came from. (A: plants convert light energy to chemical energy (i.e., their plant tissues) through photosynthesis. Animals and humans eat plants, transferring this chemical energy from plants into animals and humans. Eventually the animals, humans, and plants die, and the chemical energy is transferred into soils, where it is stored until it can be used).
- Permitting time, have students formulate innovative ideas about renewable energy devices they could build to harness the energy in soils.

Optional extension activities

***Instructor support**

Instructors should walk around, ask the groups questions to guide their exploration, and assist any groups that require help.

***Common misconceptions about the lesson**

***Opportunities to engage students in planning**

***Handouts**

A handout can be created, but is currently not associated with this lesson.