Vermont Energy Education Program
New Hampshire Energy Education Program

Electricity and the Environment: Grade 4

Workshop date(s):	VEEP/NHEEP Educator virtual call(s) with class:

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Giving students agency

Teacher Note: Learning about human impact on the environment, especially climate change and carbon emissions is important, and also anxiety-producing. Many people experience discomfort over the impact of their daily actions, worry for the world at large and our future, and anger that efforts to halt climate change have been so inadequate. Research indicates that the best way to overcome this is to focus on potential solutions even as we learn about the problems, and grow students' sense of agency and empowerment through projects they can undertake in their local communities. Focusing on what we CAN do, and looking for the actions that have the greatest positive impact creates a need for students to learn so that they can effect the changes they want to see. Focusing on what WE can do as a group (class, school, town), rather than as individuals, increases our impact and leads to community connections which increase our resilience. We offer some activities that will help students move towards this mindset in the "Elaborate" section of these lesson plans. VEEP/NHEEP has many additional resources to help teachers and students interested in having a positive impact--ask us about great projects you can do at your school!

Learning targets

- Demonstrate how electricity is transferred using circuits in different applications
- Describe how energy and fuels are derived from natural resources and their use affects the environment
- Design a goal to change use/habits of electricity

Students will explore circuits and electricity generation to provide evidence that energy can be transferred from place to place by electric currents. Students will begin to understand how they can take action to save energy. (NGSS)

Driving Question: How is energy transferred as I light this lamp?

Prior to Workshop

Set up a time to meet virtually or over the phone with your V/NHEEP educator.
Discuss:
- Content/lessons requested:

    - Class goals? Student needs?
    - Action steps/suggestions and/or community outreach
- Discuss details if a kit rental is needed (to finish the workshop or extend learning)
- Cost ($250 per workshop)
- Number of classes, students, etc

Teacher Prep

1. Have student worksheets ready. *(Here is a link to a comprehensive worksheet that can be used for the prep work as well as the workshop. You can print the pages that your students will be using. Please print double-sided.)* E&E 4 Worksheet
2. Before the workshop, ask students to model their understanding of the driving question: **How is energy transferred as I light this lamp?** Show the Vermont or New Hampshire electricity pie charts (also linked on *slide 2*) and then turn on a light or lamp. As individuals or in small groups, have them draw a diagram of how they think energy is transferred when a lamp or light is turned on, using an electricity source they find on the pie charts. Use the first two worksheet pages for this, as well as *slides 2-3*.
    a. Ideally you can collect questions that arise during this process and email them to your V/NHEEP educator so they can be sure to address them during the workshop.
    b. Be prepared to return to these models after the workshop and have students add new thoughts/ideas. This is a great way to assess student learning. See step 7 under Explain.
    c. Give an overview or review of different types of energy: light, sound, heat, electrical, chemical, mechanical, potential, kinetic-asking students to list ways they use or see these types of energy in their own lives (worksheet page 2).
3. Post Claims/Evidence chart if desired, or use *slide 8*.

Workshop Set-up:

4. Set up all equipment stations (instructions to put on the table are included in kit)
    a. Photo of generator/voltmeter set up
    b. Photo of LED/Incandescent board and hand cranks
5. Have slideshow ready to present (VEEP/NHEEP educator will make teacher their own copy)
6. Establish duration of stations.

If you are renting equipment instead of having a VEEP/NHEEP educator conduct this workshop:

1. Set up steam generation video projection (your choice of short video with no talking or long video with more explanation). *slide 4*

This template is written in the 5E Format. For more information, read *The 5E Model Instructional Model: A Learning Cycle Approach for Inquiry-Based Science Teaching*.

Check in with your V/NHEEP educator if you need help with any of this!

Engage

An activity to promote and access prior knowledge with a demo, short activity or question. An opportunity to expose students' misconceptions.

Time: 20-30 minutes

Materials:

- A lamp or other light source that can be turned on and off

- Slideshow, *slides 2-5*

Pre-question: Ask "Who understands what energy efficiency means?" Count hands raised but do not give answers. Repeat question at the end (once it's been explained) and count hands. Mark these #s in Salesforce.

Steps:

Driving Question (5 min)

1. Post the focus question at the front of the room: **How is energy transferred as I light this lamp?** Turn on a lamp or classroom lights, and ask students to consider how energy transfers to light it.

2. Turn and talk then share 2-4 examples of energy. Suggested prompts: *What is energy? What are some examples of energy?*

3. Ask students to share a few examples where they think energy is present. (Ex. Our bodies/movements, moving objects, light, sound, electric currents.)

Steam Demonstration (15 min)

1. Show steam generation video on *slide 4* (your choice of short video with no talking or long video with more explanation). Ask students to trace the energy transfer (from type to type or object to object) in this system, as a group on the white board.
    a. Ex: Electricity (outlet/cord) to **heat** (hot plate) to kinetic/**motion** (water boiling, steam moving out of nozzle, wheel spinning) to **electricity** (as the generator's magnets move near the coils of wire) to **light** (as the voltmeter lights up). Don't forget the **sound**!

2. Then ask what this demonstration has to do with generating electricity. Prompt students to guess/understand that most power plants function this way, and ask them how we might get to the heat in a power plant. (In our demo, we are using electricity to make electricity, which doesn't actually make sense!) Help them understand that energy sources like coal, oil, wood, etc are burned to boil water to make steam to turn a turbine.

3. Explain (or ask them to explain) that burning stuff to make steam pollutes the air which harms the earth. That's why solar panels and wind turbines are being used now around Vermont/New Hampshire - to try to protect the air and earth.

4. Tell your students that they will explore several stations having to do with energy transfer and generating electricity, and think about connecting these things to our environment.

Explore

A student-centered, hands-on activity with the teacher as facilitator for students to actively learn about the concept.

Time: 45-60 minutes

Materials:

- Student worksheets
- Station 1: Cow magnets, wand magnets, iron filing tube, donut magnets with wooden stand, paperclips
- Station 2: VEEP/NHEEP generator, voltmeter, alligator clips, shake and/or squeeze flashlights
- Station 3: 2-3 hand crank generators, several alligator clips, assorted motors, buzzers, bulbs (LED and incandescent), and bulb holders
- Station 4 **(two options)**:
    - Option 1: 3 batteries, 3 small incandescent bulbs, and 3 pieces of wire
    - Option 2: energy stick

- Station 5: small puzzle pieces (8), large puzzle pieces (12)
- Station 6: Light board OR LED/Incandescent holiday lights, 2 hand crank generators

Steps:

Stations (45-60 min)

1. Hand out the worksheet packets to each student/group. Explain briefly what students are doing at each station (following the worksheet), the process of rotation and timing (e.g. 5 minutes to explore and 2 minutes to record ideas/observations at each station) and safety precautions.
2. As students circulate to each station:
    - Sit with students, engage with the materials and experience all the stations while encouraging student focus.
    - Remind students to read directions for each station and record their thinking on the worksheet.
    - Set a timer and use a chime for station transitions (e.g. 5 minutes, then 2 minutes to record thinking).

Safety: The voltage and direct current produced by this VEEP equipment is low enough to not be harmful. Voltage found in electrical outlets can produce a lethal combination of voltage and alternating current. **Never touch any uninsulated conductors connected to a wall outlet!**

Station 1: Magnets. Explore with magnets to answer the questions in your worksheet. Safety: Be careful not to drop the magnets because they can break and demagnetize.

Teacher Notes: Magnets do not need to be touching something to push or pull the object. This magnetic field allows us to move magnets near coils of wire to generate electricity without anything having to make contact.

Station 2: Flashlights and VEEP generator. Use the flashlights and the generator to figure out how energy transfers to light the bulbs. Safety: Be gentle with the squeeze flashlights and the voltmeters.

Teacher Notes: The three things needed to generate electricity are magnets, coils of wire, and movement. This is the answer to the question on student worksheets 'What materials are needed to light the flashlights or voltmeter?' You may choose to explain this during the steam demo, or let students figure it out at this station. Note: Solar panels (photovoltaics) are the only way to generate large scale electricity that does not require magnets, coils of wire, and motion.

Station 3: Hand Generators and Circuits. Explain that the hand cranks generate electricity using your body's energy. Students will use them to power various items and figure out how energy is transferring. Safety: Turn these gently, even if quickly. If you hook two generators together, allow one of the crank handles to turn freely.

Teacher notes: Use this opportunity to reinforce how energy transfers and make sure students understand. You can also introduce circuits and explain or ask them to explain that a circuit has to be closed (essentially a full circle) for electricity to flow, where an open circuit (an incomplete circle) will not allow electricity to flow.

Station 4: Battery, bulb, wire. Students will replicate each of the 4 setups in their worksheet to see which ones light the bulb. Ask them to predict first which will work, and suggest they work in pairs as it is much easier to hold everything together. Make sure they see the difference in touching the wire to the side or the bottom of the bulb (pictures 3 & 4). Safety: Only use this equipment in the arrangements shown (i.e. not with other classroom materials). Caution the students: if you feel heat, disconnect the wire, you have created a short circuit with the battery.

Teacher Notes: Pictures 2 & 3 should light the bulb. An incandescent bulb needs to be connected by the side and bottom of the base to close a circuit and light up.

Station 4 option 2: Students are prompted to try to make the energy stick work. They diagram two ways that they were able to make the stick work, and one way that they did not. Students record any noticings and wonderings they have about the energy stick.

Station 5: Electricity Generation: Students put together the puzzle to compare and contrast two different types of electricity generation.

Teacher Notes: All electricity generation sources have similarities and differences. Many use steam, several burn something, etc. Talk to us if you need help debriefing this station.

Station 6: Exploring Energy & Light Bulbs. Students try out the hand generators with mini LED and Incandescent bulbs on the VEEP light board or using holiday lights. Start with 4 lights, then 3 lights, then 2 lights and finally 1 bulb (or attach two holiday light strands together). Answer the questions on the worksheet. Safety: Do not detach anything. Crank quickly but gently, please.

Teacher Notes: The LEDs should take significantly less energy and students should be able to feel it. The more bulbs being lit, the more energy being used, and students should feel that as well (though the difference between 1 and 4 LEDs is pretty minimal). Help students connect this to the fact that less energy used = less electricity generated = less pollution (esp in the case of burning fossil fuels/energy sources).

Explain

The focus is on students sharing and developing a conceptual understanding. The teacher's role is as a facilitator of the discussion and helping students be accountable for claims and evidence to resolve misconceptions.

Time: 20 minutes

Materials:

- Student Worksheets
- VEEP/NHEEP generator
- Lamp/light from the beginning of the workshop

Steps:

Scientists' Meeting: Whole Group Discussion (15-20 min)

1. Ask students to share examples (from the stations) where they saw evidence of energy. Ask them to respond to **"I used to think…..Now I think……"**. Listen for examples involving light, electricity, sound, and moving objects.

2. Introduce the term 'efficiency' (doing the same work with less energy) and discuss briefly their findings at station 6. Which bulb is more efficient?

Post Question: Ask again "Who understands what energy efficiency means?" Count hands raised. Mark beginning and end #s in Salesforce.

3. Transition to focusing on energy flow/transfer. Draw out of students an energy chain they experienced at a station and record that energy chain on the board. For example, ask a volunteer student to describe how energy

is transferred from the hand (using hand cranks) to make the small bulb light, a flashlight bulb light, or the buzzer buzz or the motor run. Where does the energy begin? Where is it flowing? What steps are involved?

   a. *Possible language: When you turned the hand crank generator, what happened? Where did the energy begin? How did the energy flow/ transfer? What moved or changed as the energy moved?*

4. For the V/NHEEP wooden generator, build an energy chain (on the board or a piece of chart paper) with students' input/guidance to show how energy moves/transfers.
   a. Possible language: *How does the energy move from place to place when I turn this VEEP generator? Where does it begin..? Flow to..?*
   b. Feel free to skip this step if you did it at the beginning of class.

5. Return to the question asked at the beginning of the session. Turn the lamp on and ask again, **How is energy transferred as I light this lamp?** As students share, encourage student use of science words (energy, transfer, and flow) rather than vague words like "it" or "stuff" to explain what's happening.

6. During this discussion (and if not done during the steam demo), explain to students that power stations use very large generators like this V/NHEEP generator that make much of the electricity for our homes and schools. For a long time, power stations have burned fuels to create steam to turn turbines that make electricity. Burning fuel pollutes the air (produces CO_2) and leads to climate change. Let's do everything we can to save electricity and also use other, less harmful ways to make electricity too (e.g. wind, solar…)

7. Return to students' models of how energy transfers to a lamp or light. Ask them to use a different color to add new understandings to their model. They should not start over or erase anything-this is a way to make their learning visible and to see how their thinking has changed.

8. Brainstorm: what can we do personally to reduce our impact on the environment?

Elaborate

Students are challenged to apply new learning in a new, different, and/or real world setting to develop a deeper and broader conceptual understanding. Great opportunity for interdisciplinary learning.

Time: varies

Classroom/school Energy Investigation:

1. With your educator, do an investigation of your classroom or other rooms in the school building. Identify where energy is being used. Be sure to write down or map the locations. Use this information in your brainstorm to identify action steps.

Brainstorming: What Can We Do?

1. As a class, brainstorm ways to use less electricity, or ways to lessen the negative impacts of using electricity. **Talk to your VEEP/NHEEP educator for assistance in planning an action project.**
   a. Ask students to think of things they can do for fun that don't use electricity.
   b. Challenge students to a Low Electricity Evening: ask them to go home and work with their family to use as little electricity in one evening as they can. Let them share their plans and alternatives the next day!
   c. Create an information campaign to share learnings with other classes/grades in your school. Check out our action project success stories page for inspiration.
   d. Share action plans with VEEP/NHEEP social media or in school newsletter.
      i. facebook.com/VTNHEnergyEducation instagram.com/vtnhenergyed
2. Explore career options related to what you just learned

a. Electrician
b. Electrical Systems Operators or Powerplant Operators
c. Electrical Engineer
d. Electrical Drafter or Architectural Manager
e. Electrical Inspector

3. Rent a VEEP/NHEEP kit:
   a. Use kW meters to measure appliance electricity use
   b. Rent our Solar or Wind engineering kits to explore how to make electricity with renewables.
   c. Send students home with our Home Energy Audit and Action poster and activities so they can assess their household energy use and make a plan to use less!

Evaluate

Assess student understanding and confirm that learning targets are met

Time: 20 minutes

Materials:

- Student worksheets
- Paper Claims/Evidence chart or slideshow

Claims and Evidence chart (15 min)

1. Ask, "What makes energy flow/transfer?" Brainstorm ideas.
2. As a group, ask students to come up with a claim about energy transfer. Record the claim, then record evidence (ideally from station work) in the class chart.
   a. *Example Claim: For energy to flow/transfer, the wire needs to touch the battery and the bulb." Evidence: When the wire didn't touch the battery, the bulb didn't light.*
   b. *Example Claim: For energy to flow/transfer, a person can push or pull on something to make it move. Evidence: When I pushed to turn the light switch, the light bulb lit up. Lighting the bulb shows that energy must have been flowing.*
3. Record 1-2 more claims/evidence as a class to model the process.
4. If desired, you could ask students to draw a few energy chains independently based on their station observations in order to consolidate learning from the whole group discussion.
5. Hand out the claims/evidence worksheet (the last page of the worksheet packet). Ask individual students to select 2-3 pieces of their evidence of energy transfer at the various stations. Have them write a claim and support it with that evidence. Decide if you want to share as a class or share some examples.
6. Wrap up the session by emphasizing what they've discovered about energy transfer, the generation of electricity for our homes/schools, etc.

Follow up

Return equipment and schedule a follow up debrief between V/NHEEP educator and teacher. Please fill out our evaluation (either conversation with your educator or on your own), scan the code below or click this link.

NGSS Standards:

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.