Energy Explorations: Tag

Overview: Learn about renewable and non-renewable resources and identify issues related to the environment from using them.

Keywords: Renewable, Non-renewable, Environmental Impact

Age / Grade Range: 5th-6th Grade students

Background: Renewable resources can be categorized by resources that regenerate in a human lifetime. Wind, solar, geothermal, hydroelectric, and biomass are examples of renewable resources.

Non-renewable resources cannot be regenerated in a human lifetime. Examples of non-renewable resources are coal, natural gas, crude oil, and uranium.

There are benefits and drawbacks to each resource used for energy. It is important to understand that there is no easy solution to fulfill the energy demands of a growing population. Here are some facts about several energy sources that may help fuel discussion:

Solar

Solar collection systems can be used to generate heat or electricity. Using photovoltaic cells, sunlight is directly converted to electricity. Additional solar systems can be used to heat water or homes.

Benefits:

- No need to connect to an existing electrical grid Useful for remote areas.
- No greenhouse gas emissions when producing electricity.
- Can be efficiently placed around structures such as on top of covered parking spots, on roofs, along walls.
- Resource regenerates each day with no fuel costs.

Drawbacks:

- Solar energy varies based on the time of day, time of year, geographic location, and weather events[1].
- Solar panels have a high initial cost with panels recouping the cost in energy savings over the lifetime of the panel. Panels can have lifespan of 20-25 years[2].

[1] http://www.eia.gov/energyexplained/index.cfm?page=solar_home

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- As panels age their efficiency decreases in generating electricity.
- Solar energy needs to be collected over a large space to be efficient. Solar collectors are one way to increase solar panel efficiency by having mirrors redirect sunlight to a solar collector. While this increases the energy collection from the sun, any wildlife passing through the collection point can be killed from the intense heat reflected from the mirrors. The heat is dependent on the number of mirrors used in the system. Industrial/commercial systems have this capacity[3].
- Installation can cause habitat fragmentation.

Wind

Electricity is generated by wind spinning giant blades connect to a generator. Wind is created by movement of air due to uneven heating of Earth's surface from the sun. This uneven heating creates convection, air currents, high pressure and low pressure zones. At night, uneven cooling creates the same patterns[4].

Benefits:

- Can work whenever there is wind, no dependency on day or night.
- Does not generate greenhouse gas emissions when generating electricity.
- Regenerates with the heating and cooling of Earth.

Drawbacks:

- Wind turbines can kill birds and bats[5].
- Need to be placed in high wind areas to work efficiently.
- Turbines generate a lot of noise which reduces their placement in residential areas[6].
- Turbines disrupt the visual impact of a landscape.
- May require energy to start blades spinning
- Can fragment habitat

Geothermal

Water that is heated by the Earth's magma drives turbines to generate electricity[7].

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[2] http://www.solarpanelinfo.com/solar-panels/solar-panel-cost.php

[3] http://www.scientificamerican.com/article/solar-farms-threaten-birds/

[4] http://www.eia.gov/energyexplained/index.cfm?page=wind_home

[5] http://news.nationalgeographic.com/news/energy/2014/04/140427-altamont-pass-will-newer-wind-turbines-mean-fewer-bird-deaths/

[6] http://www.conserve-energy-future.com/Disadvantages_WindEnergy.php

[7] http://energy.gov/eere/geothermal/geothermal-faqs

Benefits:

- Does not produce GHG when producing electricity.
- Renewable as the heat is gathered from Earth.
- Stable output of electricity and low cost of maintenance.
- No fuel costs.

Drawbacks

- Immense initial costs to drill wells (One 1,500 meter well could cost $2.3 million and it might not work)[8].
- Without proper management, geothermal plants can siphon heat faster than it can be replenished[9].
- Restricted to locations with high geothermal activity[10].
- May cause earthquakes[11].

Hydroelectric

There are several forms of hydroelectric generation. Typical generation is from a dam that blocks a river and lets water out past a turbine to generate electricity. New technology and ideas are expanding hydropower to include using tides to generate electricity[12][13].

Benefits:

- Constant generation of electricity.
- No GHG emissions from producing electricity.
- Renewable through the water cycle.

Drawbacks:

- Costly to install and may divert stream flow.
- Can cause stream bank erosion.
- Alters the landscape behind the dam effecting plants, animals and humans.
- Can emit the greenhouse gas methane as plants decay[14].
- Disrupts water quality downstream as nutrients are blocked by the dam.
- Can disrupt fish spawning if fish ladders/cannons not installed.

[8] https://www1.eere.energy.gov/geothermal/pdfs/egs_chapter_6.pdf

[9] http://energy.gov/eere/geothermal/geothermal-faqs

[10] http://energyinformative.org/geothermal-energy-pros-and-cons/

[11] http://energyinformative.org/geothermal-energy-pros-and-cons/

[12] http://www.eia.gov/energyexplained/index.cfm?page=hydropower_home

[13] http://education.nationalgeographic.com/education/encyclopedia/tidal-energy/?ar_a=1

[14] http://ecowatch.com/2014/08/14/dams-not-clean-energy-climate-change/

Biomass

Biomass uses plant or animal matter to create fuels. Biomass can be directly burned or converted into biofuels. A notable example of this would be soy bean and corn converted into alcohol. Corn and soybeans are categorized as first generation biofuels. Second generation biofuels are produced from woody sources such as left over piles of unused timber from harvesting called slash and unused lumber from construction sites. Biomass can also come in the form of animal manure and human waste. Harvesting natural gas from landfills is considered a type of biomass[15].

Benefits:

- Depending on the source, biomass can be renewed in years or months.
- Carbon neutral process (Burning the fuel releases carbon dioxide, but growing the next batch absorbs carbon dioxide)

Drawbacks:

- Expensive to produce (Technology has allowed us to harness plants for fuel, however the process is still being refined)
- There needs to be enough space to grow the biomass.
- The rate of consumption of biomass must be monitored carefully to avoid harvesting at a higher rate than production[16].

Coal

Coal is the most common fossil fuel produced in the United States. Coal is a sedimentary rock composed of carbon and hydrocarbons formed from decaying plant matter over millions of years[17].

Benefits:

- Provides a constant, predictable generation of electricity.
- Energy source is stable enough for transportation, handling and storage for future use.(Coal will remain coal at room temperature)

Drawbacks:

- Creates GHGs when burned, harvesting, transporting and refining coal.
- Mining coal can create sulfuric and carbonic acids which can enter streams damaging or destroying watersheds and habitats.
- Harvesting can damage the environment if reclamation is not done.

Natural Gas

Decaying plant and organic matter is covered by sand and silt. Over millions of years heat and pressure convert the matter into coal and natural gas. Geologists study the bedrock to determine where natural gas deposits are

[15] http://www.eia.gov/energyexplained/index.cfm?page=biomass_home

[16] http://energyinformative.org/biomass-energy-pros-and-cons/)

[17] http://www.eia.gov/energyexplained/index.cfm?page=coal_home

likely located to drill. Most natural gas consumed in the US is produced in the US. Natural Gas is a fossil fuel[18].

Benefits:

- Energy security (Since the US produces most of what it consumes the risk of a shortage is low)
- Provides a constant generation of electricity.
- High energy release when burned.

Drawbacks:

- When used, emits GHGs. Also emits GHGs during transportation.
- Extremely flammable and must be contained and transported in a special way to prevent explosions.

Crude Oil

Oil is formed from the remains of plants and animals that lived in a marine environment. Creation of oil takes place over millions of years. Many products can be created out of oil such as jet fuel, heating oil, diesel, other petroleum products (Vaseline), and gasoline. Plastics come from oil and can be made into many products like containers and clothing[19].

Benefits:

- It is a versatile resource.
- Generates a constant amount of electricity.
- Globally abundant.

Drawbacks:

- Generates Greenhouse Gases when used, transported, and refined.
- Types of crude oil vary in composition. Depending on the type of crude it could require little or significant refining. Canadian Tar Sand oil would require significant refining due to its composition.
- Harvesting crude can damage the environment.
- If an accident occurs such as spills or leaks, the environment will be harmed.

Uranium

Uranium is a radioactive element that undergoes nuclear fission and is the only non-renewable non-fossil fuel. As the uranium undergoes fission, a splitting of atoms, it heats water surrounding it. This energy is transferred to a closed system with a turbine generator. The heated water from the uranium heats the water with the turbine creating steam which spins the turbine and generates electricity. Control rods regulate the rate of fission[20].

[18] http://www.eia.gov/energyexplained/index.cfm?page=natural_gas_home

[19] http://www.eia.gov/energyexplained/index.cfm?page=oil_home

[20] http://www.eia.gov/energyexplained/index.cfm?page=nuclear_home

Benefits:

- Stable generation of electricity.
- Resource can generate electricity for a long period of time before being replaced.

Drawbacks:

- After the fuel is spent, the uranium is still highly radioactive and needs to be carefully stored to prevent leakage and water contamination. This spent fuel will remain dangerous to humans for thousands of years.
- While power plants are engineered for durability, if a reactor overheats, fails, or becomes damaged, the surrounding area needs to be evacuated until the reactor is fixed. Examples would be the Fukshima reactor and Chernobyl reactor. The area affected by radiation depends on the damage. Traces of radioactive water was detected on the west coast of the US several months after the reactor in Fukushima was damaged.
- Retired reactor water also needs to be stored safely since it is heavily contaminated with radiation.

It is important to understand that there is no easy solution to fulfill the energy demands of the people.

Next Generation Science Standards

5-ESS2-1: Develop a model using an example to describe ways to geosphere, biosphere, hydrosphere, and/or atmosphere interact.

5-ESS3-1: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

MS-ESS3-4: Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

Common Core:

RI.5.9: Integrate information from several texts on the same topic in order to write or speak about the subject knowledgeably.

MP.2: Reason abstractly and quantitatively

RST.6-8.7: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually.

6.RP.A.1: Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

Goals: Students will participate in an active game to simulate resource harvesting from the environment. They will explore the costs and benefits of renewable and non-renewable resources to better understand the dynamics of creating sustainable energy use patterns for the future.

Objectives: Students identify examples of renewable and nonrenewable resources.
Students identify the sources of energy resources from the environment.
Students compare and contrast energy sources.
Students observe the impacts of harvest on energy resources.
Students apply their observations about energy resources to current problems in energy demands.

Materials: Energy Cards (Same information in Background Section, student friendly)
Flags or cones to mark boundary

Set up: This is an active running game that should take place in an open area free of tripping hazards. A smaller area will make the game last for a shorter duration. A field group of 8 should have a square field of approximately 12 feet by 18 feet. Field size is also dependant on ground conditions. In snow or sand the field should be smaller.

For an accurate simulation of resource harvest, the person tagging can guard/puppy guard/hover.

Classroom Time: One 30 minute community

Overview

1. Setup a boundary area for students to run in.
    a. Emphasize that they need to stay in the boundaries
2. Pass out round one, non-renewable energy cards
    a. Emphasize that students not tell each other what energy resource they represent.
    b. Demonstrate what happens when tagged and where is the "out" zone.
3. Play until there are no more resources left.
    a. Smaller fields will have faster games.
4. Debrief round one
    a. Focus on the amount of resources left and what happened to them.
    b. Collect cards
5. Distribute round two cards, renewable.
    a. Same rules as round one.
    b. Make sure students understand their cards
6. Play round two for approximately five minutes.
7. Debrief round two
    a. Review the differences between round one and two
    b. Review what each resource is, renewable or non-renewable, and the benefits and drawbacks of each.

Introduction (Engage):

Note: Text in "quotations" signifies suggested dialogue to engage students in and is not intended to be a script. Use your best judgment when delivering these lessons.

"What do you use at home that requires electricity?" (Field answers)
"Where does that electricity come from?" (Field answers)
"There are many different ways to generate electricity. Can anyone name an example?" (Field answers to include as many as possible: coal, oil, natural gas, nuclear, wind, solar, geothermal, hydroelectric, and biomass)
"We're going to simulate how people gather the resources needed to generate electricity." (Set up field now, or you could do it before they arrive in the morning)

Activity (Explore):

Rules of the game:
(Standing in the boundaries) "This area represents a gathering site. You will be representing a resource and you must stay within these boundaries. Since humans can't reach down and grab resources with their hands we have to be creative. For oil and coal we have to dig for it, a difficult job. To simulate this effort needed to gather resources this will be a tag game! One of you will be the human and your job will be to go around 'gathering' resources by tagging them. We will play this game for 2 rounds. I will give you a resource card, keep this information private to yourself. DO NOT SHARE ANYTHING ON YOUR CARD UNTIL I SAY SO, IT'S PART OF THE GAME!"

(Each card has a picture of represented resource on the front. The back has instructions for what the student needs to do if tagged. It will provide them a time to crouch down until they are back into the game and how many lives they have)

"On the back side of the card there are instructions for you to follow if you are tagged. Read them to yourself and if you have any questions COME SEE ME! For example, the back of your card might say an amount of time to crouch

down if tagged and a number of lives." (Demonstrate counting and crouching)

"Each time you are tagged deducts one life. Who wants to be the human? Ok my human gatherer- wait over by that flag/cone. Everyone else- I'll give you a resource card." (Hand out ROUND 1 resource cards)

"Ok resources, spread out get ready! Human ready? Resources ready? GAME ON!" (Round 1 has all non-renewable cards, game play will end when there is nothing left to harvest) "Why weren't there any resources left at the end? What happened to them?" (Field answers)

Round 2
"Let's simulate a different resource field! Pass back your cards. Who wants to be the new human? Ok human- wait over by that cone/flag. Alright resources go ahead and scatter, remember to keep your card information to yourself, don't shout anything out! (Go to each student and give them a ROUND 2 resource card. These cards will give students an infinite amount of lives) Ok, everyone ready? Game on!"

(You should see a difference in how resources run, Round 1 will be hectic and fast, round 2 might have a lot less running and a lot of not caring if they get tagged. You will need to end this after a period of time since everyone has infinite lives. When you are done collect the ROUND 2 cards and have your group get in a circle)

Explanation

"Think about how you felt as a resource in round 1 or if you were the human at the end of round 1 and sum it up in 1 word." (Hopefully you will hear 'scared, afraid, fearful')

"Now think to round 2, how did you feel, again summing up in 1 word. (Field answers) Why did you feel that way?" (Field answers)

"What were you in round 1 compared to round 2?" (Have students share what they were) What differences did you notice from round 1 to round 2?" (Field answers)

" Who had Coal? What were some drawbacks or benefits you remembers? (Field answer for Coal. Continue to do this for all energy resources) Do you know what renewable means? Which round would you say had renewable resources? Which round had non-renewable resources? What do you think is key to be renewable for humans?" (Field answers)

Elaboration/ Content-Tie in:

"Depending on where you live, how you live and what you chose will influence the resources you need. Should we use all of one resource? Should we diversify? These questions you will come up again and again as you get

older. Now you have the knowledge to help make a decision. Any questions?"

You can bring this up again in What's a Watt Worth and Value of a Tree.

What's a Watt Worth:
A brief review of where does electricity come from and what sources generate it.

Value of a Tree:
When referring to the slash piles this activity could be brought up as a way to use the leftovers for creating biofuels with or leaving them on the ground to recycle nutrients back into the soil.

Evaluation:

Students may write or draw an energy plan in their journals or discuss aloud depending on time.

"Work with a partner, to come up with an energy plan for the future. Describe what types of resources you would want to use and why."
Encourage pairs to present to the whole group.

Additional resources:

See Appendix C for materials