Introduction to Energy

What is energy?

Broadly speaking, **energy** is what is required to do work and it exists in many different forms. According to the first law of **thermodynamics**, energy can neither be created nor destroyed but it can be converted from one form to another. For example, **thermal** and **kinetic** energy are commonly converted to **heat** and **electrical** energy. As the global population rises, the demand for energy increases. To meet the demands for energy (specifically **electricity**), countries must develop **sustainable** methods of generating energy.

How is electricity generated?

The most common method of generating electricity is by using a **turbine generator**. This generator contains a series of rotor blades that when rotated, converts kinetic energy into electricity. Rotating these rotor blades usually require water, steam, or air which come from external energy sources.

There are two types of energy sources: **non-renewable** and **renewable**. Non-renewable energy sources occur in limited supplies and are not naturally replenished. On the other hand, renewable energy sources are natural resources that are replenished daily. Electricity generated from renewable energy sources are known as **clean energy** since these processes result in virtually no carbon emissions. For a sustainable future, clean energy should only be used to meet our energy demands.

What are the types of non-renewable energy sources?

Fossil fuels are the main source of energy for the world. They are formed from the buried remains of organisms that lived millions of years ago. Fossil fuels include **coal**, **natural gas**, and **petroleum**. Both coal and natural gas are burned to generate heat and electricity while petroleum is mainly converted to fuel for vehicles. The use of fossils fuels has been discouraged due to its negative effects on the environment. Burning fossil fuels generate **greenhouse gases** which are responsible for **global warming** and **ocean acidification**.

Nuclear energy is seen as an alternative to fossils fuels as it produces little to no greenhouse gases. Nuclear energy is released from **nuclear fission** or the splitting of the nucleus of an atom. **Uranium** mined from Earth's crust is main resource consumed in this reaction. Nuclear fission produces enough energy to turn water into steam which can then be used to power turbine generators. Despite net zero emissions, the use of nuclear energy has adverse risks for the environment. Radioactive waste generated from nuclear reactions and nuclear power plants accidents lead to severe environmental damage.

What are the types of renewable energy sources?

Solar energy from the sun can be captured and directly be converted to electricity by **photovoltaic** cells. This conversion of energy is possible due to the photovoltaic effect where light excites electrons, generating voltage in the process. Solar power can easily be implanted into neighborhoods and cities through the installation of **solar panels**. Currently, solar energy must be used in combination with other energy sources to power cities through the night. This is due to the absence of efficient storage of electricity generated in the day.

Hydropower refers to the generation of electricity by using running water. Utilizing hydropower requires the construction of **dams** to divert water from rivers towards turbine generators. Hydropower is a main energy source for states where there are large bodies of running water such as Washington. The downside of hydropower comes from the construction of dams which can destroy river ecosystems and displace people from their homes.

Wind is utilized by **wind turbines** to generate electricity. Wind turbines are scaled up turbine generators that have a single giant propeller-like blade. Wind turbines are usually built-in remote locations where there are plenty of space. The efficiency of wind power is limited by the availability of wind and its speed. Despite no air pollution, wind turbines can contribute to noise and aesthetic pollution.

Biomass refers to plant-based material that can be used as fuel for heat and electricity. Biomass includes wood, sugarcane, corn, plant waste and much more. Burning biomass produces less carbon emissions than fossil fuels, however there is still debate on the actual climate impact of this process. Furthermore, harvesting biomass can damage the **biodiversity** of the environment due to destruction of animal's habitats and resources.

Geothermal energy is the thermal energy within the earth's crust formed from the radioactive decay of minerals. This type of energy can be utilized to heat water and even generate electricity via steam. Most geothermal plants are located near the edges of **tectonic plates** where volcanoes are active. The cost of geothermal energy comes from drilling into the earth's crust to extract the heat. In addition, drilling deep into the earth can release greenhouse gases and toxic elements.

How can we reduce energy consumption?

For a sustainable future, consider practicing **energy conservation** and **energy efficiency**. To conserve energy, consider riding a bike or using public transportation instead of driving your car. Be sure to turn off electronic devices and lights in your household when not in use. To use energy efficiently, consider replacing incandescent light bulbs with fluorescent light bulbs. Also consider installing solar panels on your home. Not only will this reduce the energy consumed from the electric grid, but it will also save you money in the long run. Together, we can take small steps to reduce the amount of energy we consume.

Proposed Lesson Plan

Introduction

1. Probe the student's knowledge of energy. Ask them what they know and don't know.
2. Introduce energy. Hand out the Introduction to Energy reading. Answer any questions they may have.
3. Split groups up for Main Activity.

Main Activity

1. Give each group a description of environment (e.g., town next to river or big city on the coast of California) and multiple cards that contain a single energy source. Each energy source will contain an energy efficiency value and carbon emissions value. Higher value for energy efficiency means higher efficiency while higher value for carbon emissions means higher emissions.
2. Have the students discuss which energy sources will be appropriate for their environment. Then have them discuss what combination of energy sources will lead to more efficient energy generation.
3. Now have the students discuss the potential cons of their chosen energy sources. Answer can be based on the reading or the carbon emissions value.
4. Allow the students to change their energy sources to mitigate the cons.
5. Discuss with the students the tradeoffs of their decisions.
6. If there is time, repeat this with new environment cards.

Summary

1. Why are fossil fuels harmful?
2. What is clean energy?
3. Is it possible to fully transition to clean energy?
4. What other ways can we conserve energy?
5. Why do you think it is difficult to transition to clean energy?