Activity Pages Answer Key: *Using Natural Resources for Energy*

This answer key offers guidance to help you assess your students' learning progress. Here, you will find descriptions of the expectations and correct answers for each of the Activity Pages of this unit.

What Is a Cost-Benefit Analysis? (AP 1.2) (page 132)

- a study of the costs and benefits associated with an action
- People use cost-benefit analysis to better understand the solution to a problem.
- You can find the strengths and weaknesses of a solution.
- You should consider alternatives to a decision because they may have better results.

Lesson 2 Check (AP 2.1) (page 134)

1. sunlight, wind
2. coal, gas, nuclear power, petroleum
3. The benefits of renewable resources include: no emissions, better for climate, can decrease pollution, better for health and environment, it is reliable and will not run out
4. The benefits of renewable resources include: more difficult to generate as much power; disruption of ecosystems and habitats; intermittent availability of energy
5. Renewable resources can be used over and over. Nonrenewable resources take much longer than a human lifetime to be replaced.

Costs and Benefits Practice Sheet (AP 3.1) (page 135)

Accept all plausible cost-benefit analyses students turn in.

Lesson 3 Check (AP 3.2) (page 136)

1. a
2. Option B wasn't consensus because there was no opinion or statement of fact that was shared among the players. They just scored baskets. Option C involves a rather small percentage, so that isn't a consensus. Option D is more about behavior than any kind of agreement among the aunts.

AP 3.2, continued

3. Sample answer: If it's a person I would look for evidence of expertise, such as years of education and multiple degrees in a relevant subject. I would also look at who they work for. If they are working for a company that sells a particular energy resource or product, then I might be skeptical. If the source is an organization or part of the media, I would look at how large or widely read it is, and I would separate opinion articles from news articles. If it is a U.S. government site I would assume it is probably reliable but would not assume everything it offers is factual.

Formation of Fossil Fuels (AP 4.1) (page 137)

- Student drawings should show plant and animal remains buried under the sea. Students may indicate the heat and pressure that help change the remains.
- Students should identify their fossil fuel.
- Students should identify where the fuel is found.
- Student explanations should indicate heat and pressure change remains to a fossil fuel.
- Students should note that it generally takes millions of years for a fossil fuel to form.

Fossil Fuel Diagram (AP 4.2) (page 138)

Student Venn diagrams could show difference of the different properties of each fossil fuel such as being solid, liquid, or gas. Similarities would include being from the remains of living things and the transformation due to heat and pressure.

Fossil Fuel Costs and Benefits (AP 5.1) (page 139)

- Benefits: can be used to produce many different things besides energy, releases much energy
- Risks: pollution, nonrenewable so they will run out
- The environment might be cleaner but people would have to find more plentiful energy sources.
- Accept all plausible student responses.

Electricity Diagram (AP 5.2) (page 140)

Student diagrams should show coal being burned, releasing heat, which creates steam. In turn, the steam spins a turbine, which spins a generator.

Costs and Benefits of Fossil Fuels (AP 6.1) (page 141)

1. environmental damage, or change, in the form of carbon emissions in the atmosphere

AP 6.1, continued

2. petroleum
3. natural gas
4. destruction of natural habitat, release of coal dust and chemicals into the environment, exposed pit is hazardous and hard for natural habitat to reclaim

Sample table:

	Costs	Benefits
Petroleum	Carbon emissions into atmosphere (global warming) Can spill as harmful pollution Nonrenewable, so extraction is becoming more costly (deeper drilling, etc.)	Abundant resource that can be made into energy-rich fuels as well as plastics and other useful products Relatively easy to transport (does not require compression) Can be burned to power engines in vehicles
Coal	Carbon emissions (worst of the three fossil fuels) into the atmosphere Mercury and other chemicals also emitted Pollution from coal mining, wastewater ponds Mining is dangerous and harmful to landscapes, especially strip mining.	Abundant, cheap form of chemical energy that can be burned to produce heat for direct use or for generating electricity Solid, so it is easy to transport
Natural gas	Methane is a powerful greenhouse gas, and even if burned it results in carbon emissions (global warming). Gas is difficult to contain if not controlled. Highly explosive/flammable Pollution from fracking	Burns more cleanly than petroleum fuels and coal Can be transported by pipeline or compressed for transport by ship

Lesson 7 Check (AP 7.1) (page 142)

1. The material required is rare and difficult to enrich. There is a limited amount available on Earth.
2. It remains radioactive and therefore very dangerous for a very long time. This means the handling and storage of nuclear waste is very expensive and risky.
3. In both, energy from the materials is converted into heat, which is used to boil water into steam, which passes through a turbine that powers a generator, which makes electricity.
4. The nuclear chain reaction can go out of control and release far more energy if an accident occurs.

AP 7.1, continued

5. Nuclear power has no carbon or methane emissions, so it does not enhance the greenhouse effect the way carbon and methane emissions from the fossil fuel industry do.
6. Nuclear power is used in some very large vessels, such as submarines and aircraft carriers, but for the most part a reactor and the other equipment needed take up too much space to be used in vehicles. Nuclear power also does not directly produce fire, whereas other fossil fuels or their products can be burned at small scales and used for a variety of purposes.

Nuclear Power Costs and Benefits (AP 8.1) (page 143)

1. lack of carbon emissions
2. Answers will vary. In some states nuclear power accounts for over 50% of electricity production.
3. Unless accidents occur the long-term costs of nuclear power should be less than those of fossil fuels, because nuclear power does not involve emissions of carbon or other greenhouse gases. However, nuclear waste requires safe, secure

storage for many years. This means nuclear power would cost a lot of money even if all of the nuclear power plants were shut down.

4. Nuclear power can be used to make extremely destructive weapons. The other major energy resources do not have the same capacity for being weaponized.

Sample table:

	Costs	Benefits
Nuclear power	Fissile material is radioactive/dangerous, and so is the waste (spent fuel rods). Very expensive to build a nuclear reactor and power plant Difficult to engineer a reactor for use in transportation Can be used in weapons Chain reaction can be very dangerous if not controlled (Chernobyl, Fukushima accidents)	No carbon emissions Only by-product is heat, which can be safely released into the environment through cooling towers or effluent water Could offer the best hope of replacing fossil fuels for electricity production

Lesson 9 Check (AP 9.1) (page 144)

1. The rotations of the turbine shaft have to be converted to a larger number of rotations that spin inside the generator. This is necessary to generate electricity.
2. A lot of wind means more wind energy that can be converted into electricity, but too much wind can overwhelm the turbine or do damage to it.
3. The wind does not blow all the time, and even if it does it might not blow hard enough to spin a turbine fast enough to make electricity. This means that some other source of energy to make electricity is probably needed or that large batteries are necessary to store the electricity from a wind-only system.
4. The grid is the network of power lines, towers, and other technology that transmits electricity to homes and other buildings.
5. How much wind does the location get on average every day, and for how many hours? What are the potential sites like in terms of terrain, ground, wildlife,

and human activities? How costly would it be to hook up the turbines to the grid? Is battery storage an option? What other sources of energy could be used along with wind?

Wind Power Costs and Benefits (AP 10.1) (page 145)

1. renewable, doesn't produce carbon emissions
2. It requires a certain amount of wind to spin the turbine and generator fast enough to generate electricity, and too much wind can be a problem.
3. Turbines can injure or kill flying wildlife, such as birds and bats.
4. The towers could be dangerous obstacles for boats. A toppled tower could be very expensive to fix. Undersea cables transmitting the electricity to land could break. The large turbine blades could strike migrating seabirds. People could complain about the sight of the turbines.

Sample table:

	Costs	Benefits
Wind power	Utility-scale turbines and wind farms are very expensive to build and maintain. There are some environmental problems, including injuries and deaths of birds and bats and changes to habitats due to tower construction and building/using access roads.	No carbon emissions Renewable energy resource (wind) is abundant in many locations. Farms can be established in places that are relatively unused, such as areas of the ocean or plains, or even on agricultural farms or ranches, allowing people to increase their income or switch from a nonsustainable business to a sustainable one.

Lesson 11 Check (AP 11.1) (page 146)

1. gravity
2. Both are spun by matter moving past the blades.
3. Advantage: steady supply of water; disadvantage: glacier could eventually disappear and the dam will not have enough water to work with
4. A river fed by rainfall and melting snow is a more reliable source of moving water. It isn't dependent on a single mass of ice that might eventually disappear. Over the long run, it is more likely to be cost effective because the source of the water is more likely to be sustained.
5. Severe rainstorms or unusually heavy snowfalls could result in flooding that overwhelms or even breaks a dam. Severe drought could cause rivers and reservoirs to run so dry that dams cannot produce much electricity. Either scenario could make a dam very ineffective in terms of cost.
6. salmon and other migratory fish, trees that depend on nutrients from decaying salmon

Hydroelectric Power Costs and Benefits (AP 12.1) (page 147)

1. It doesn't produce carbon emissions.
2. Impoundment facilities greatly reshape rivers and the landscape both upstream and downstream from them. They also interfere with fish migrations.
3. Hydroelectric power usually relies on the water cycle to replenish supplies of water upstream from the facility. If the water cycle changes, resulting in either more or less precipitation upstream from the facility, the productivity could be changed.
4. If a river or reservoir floods, the dam can fail, resulting in a sudden flood of the downstream area as well as damage or destruction of a very expensive facility and a source of energy.
5. The production and use of thousands of tons of concrete result in a lot of carbon emissions. A lot of energy is used to build such facilities, and that energy is unlikely to be clean.

Sample table:

	Costs	Benefits
Hydroelectric power	Utility-scale facilities are very expensive to build and can alter and disrupt landscapes and lives both upstream and downstream. Migratory fish such as salmon can be blocked from returning to their native streams to spawn, and larval fish can be harmed as they pass through dams toward the ocean.	No carbon emissions It's a form of renewable energy resource (moving water) that is abundant and reliable in many locations, including some coastal areas of the ocean. Little to no pollution of any kind

Lesson 13 Check (AP 13.1) (page 148)

1. Photons in sunlight strike the material in a solar cell, which excites the material's electrons. Electrons freed from atoms can flow as electricity.
2. A solar cell is the basic functional unit of a photovoltaic device.
3. The technology is not very efficient yet. Many areas of Earth's surface do not get enough sunlight, and most locations experience night—no sunlight—about half the time.
4. Both technologies supply heat that is used to generate steam that spins a turbine that powers an electric generator. Solar energy is concentrated and controlled to generate heat just as a nuclear reaction is controlled to generate heat.
5. If a desert starts to receive more clouds due to changes in the region's climate, there would be less sunlight striking the light-absorbing or light-reflecting equipment. This would reduce the electrical output of the facility.

AP 13.1, continued

6. No. If sunlight is available, then the panels will convert it into electricity. Whether the air is warm or cold does not change the photons that travel from the sun to Earth's surface.

Solar Power Costs and Benefits (AP 14.1) (page 149)

1. It doesn't produce carbon emissions.
2. Initial investment can be very high, and there are times when it is not available, both in a day or at certain times of the year, depending on the location.
3. Solar power panels or mirrors for solar thermal power both require a lot of sunlight, which means the sky must be relatively clear.
4. No. There is often a lot of transportation involved in the manufacture, transport, and setup of solar power plants, which means using other energy resources.

Sample table:

	Costs	Benefits
Solar power	Utility-scale facilities are very expensive to build and require a lot of space. Very weather dependent, and some locations do not get enough sunlight even if the weather is clear. Rooftop solar remains too expensive for most people to afford. Storage of solar-generated electricity is expensive.	Renewable energy, extremely abundant Little to no pollution of any kind Homeowners and small-scale solar power generators can generate income by selling electricity to the grid. Low maintenance costs

Lesson 15 Check (AP 15.1) (page 150)

1. Heat moves from warmer to cooler materials.
2. Geothermal energy is heat from Earth's interior. Solar energy comes from the sun in the form of light.
3. It usually requires a site on land where there is an abundant and reliable source of geothermal energy not too far from the surface, such as a hot spring or a reservoir of steam. There just aren't that many sites like this.

AP 15.1, continued

4. Low-temperature geothermal plants can use liquids with lower boiling points to drive a turbine. This means the source of geothermal energy from the ground does not need to be as hot.
5. Wastewater can cycle in and out of the abandoned oil field. Heat from the rock around the well warms the wastewater, and that heat is removed from the water when it is pumped to the surface.
6. They would need to know if there is enough geothermal energy in the crust of the island. If the island is volcanic, then it might work.

Geothermal Energy Costs and Benefits (AP 16.1) (page 151)

1. It doesn't produce carbon emissions.
2. It can be hard to find. Large-scale geothermal energy plants are expensive.
3. Thermal energy at 50°F can be brought directly into a home. Thermal energy of geysers can be converted to electricity, which can then be used to warm a home.
4. Locations that have volcanic activity below them are more likely to have abundant geothermal energy than other locations.

Sample table:

	Costs	Benefits
Geothermal power	Utility-scale facilities are very expensive to build. It can be difficult to find locations with adequate, reliable reservoirs of geothermal energy. Sustainability depends on maintenance of the resource, such as pumping cooled fluids back into the ground.	Renewable energy Little to no pollution Can be used at large or small scale Low-temperature plants can generate electricity from relatively cool geothermal fluids, including recycled wastewater from abandoned oil fields. Does not require a lot of space on Earth's surface Technology can be used to both warm and cool things on the surface (e.g., heat pump technology for homes).

Lesson 17 Check (AP 17.1) (page 152)

1. methane hydrate
2. Both are made of carbon-rich chemicals made by and for living things, but biofuels are made from nonfossilized remains instead of fossilized remains.
3. They are burned like fossil fuels, so they emit carbon into the atmosphere.
4. A gasoline engine makes the car move some of the time, mostly at higher speeds. When the brakes are applied, the electric motor is used to slow the car, and the energy is converted to electricity that gets stored in a battery. The battery powers an electric motor that can also make the car move, mostly at lower speeds.
5. When electricity is run through liquid water, it generates hydrogen gas. This gas can be captured and compressed into a tank that can be placed in a car.
6. Hydroelectric energy is based on water being pulled downhill by gravity or pulled across Earth's surface by gravity between ocean water and the moon and sun. The moving water provides the energy of motion to turn turbines. Wave motion energy is really a product of wind energy making waves, whose up-and-down motion can be converted into electricity.