REACH COMMUNITY PROJECT RESEARCH PRACTICE

Final Unit: Community Project
Grades 4-6
INSTRUCTIONS

Overview

In this lesson students learn more about alternative energy through a guided activity. Conducting research is a skill that must be taught. Students will gather information from the provided Student Information Sheets, and then they will apply their own background knowledge about their local community to draw conclusions.

Objectives

On successful completion of this lesson, students will be able to:

- define the vocabulary term research;
- list four different types of alternative energy; and
- identify an alternative source of energy that could work well in their community.

Alaska Standards

Anchor Standards for Writing Grades K-12

Research to Build and Present Knowledge

- Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation. (W.7)

Science Content Standards Grades 3-12

Science as Inquiry and Process

- Develop an understanding that culture, local knowledge, history, and interaction with the environment contribute to the development of scientific knowledge, and local applications provide opportunity for understanding scientific concepts and global issues. (SA.3)

Materials

- Student Information Sheets:
  - Hydrokinetic Devices
  - Wind Turbines
  - Photovoltaic Solar Panels
  - Biomass Technologies
- Student Worksheets:
  - Hydropower
  - Wind Power
  - Solar Power
  - Biomass Power

Whole Picture

Every day, people use natural resources for a variety of purposes. One main use is for energy. People need energy to power their homes, fuel their vehicles, grow their food, make the textiles for their clothing, and to provide heat when the weather turns cold.

Energy sources can be split into two main groups: renewable and non-renewable. Those that are renewable can be used conservatively again and again without fear that they will disappear. These include solar, wind, geothermal, hydropower, and biomass energy. Non-renewable sources are those that take millions of years to replenish, and as such, once today's humans have exhausted them, they will disappear. These include oil, coal, and natural gas.

Modern society relies heavily on non-renewable resources to provide electricity, heat, and fuel for travel. Scientists and elders alike know that the extraction and use of these energy sources are contributing to climate change (Fienup-Riordan and Rearden, 2012; Krupnik and Jolly, 2002). As a result, people around the globe are beginning to develop renewable resources for energy — including in the expansive state of Alaska! Many villages are experimenting with renewable resources, such as biomass, wind, geothermal, and solar, as a way to reduce their dependence on pricey fossil fuels.

Biomass is carbon-rich material from living, or recently living organisms, that is (typically) burned for energy. While the plants are growing, they take carbon out of the atmosphere, and when they are burned, the carbon is released back into the atmosphere. Sometimes, materials used for biomass energy are grown specifically for that purpose, such as grasses and hemp. Other times, biomass energy materials come from the waste products of other sources. For example, waste wood can be used for wood burning boilers, though it is prudent to know how the wood has been treated, so as to avoid toxic off-gassing and ash (Biomass Energy Centre, 2011). In several rural Alaska villages, wood-burning boiler systems are being installed to ease the high cost of using heating fuel — though many of these villages are in interior and southeast Alaska, where wood is a plentiful resource.

The sun is also a source of renewable energy. Solar arrays, designed to capture the sun's energy, are becoming more popular around the globe. Because Alaska is "The Land of the Midnight Sun," many believe that solar energy would be a profitable alternative energy resource. However, due to the long periods of darkness during winter, and the difficulty in storing solar energy long term, "utility-scale solar power plants are uneconomical in Alaska" (REAP, 2015). Nevertheless, stand-alone solar grids in remote areas are useful, and much of the solar development in the state is being done on small scales. In Nome, for example, the Bering Straits Native Corporation has a solar array on their office building, and they are able to offset about "1,000 gallons of diesel fuel annually" (REAP, 2015).

Another useful renewable energy resource in Alaska is wind. Turbines placed in strategic locations can harness the power of the wind, which is then used for electricity, heat generation, and therefore displacement of diesel fuel use. The first wind program in Alaska was installed in Kotzebue in 1997. Since then, additional turbines have been added, and "the wind farm displaces 80,000 gallons of diesel every year" (REAP, 2015). Wind turbines have also been installed in Gambell, Savoonga, Shaktoolik, and Unalakleet, in addition to other villages in the

state. These turbines help reduce the price of electricity for villagers, help villages meet their electric demands, and provide the heat for water treatment and drinking water plants.

Other renewable resources, like geothermal and hydropower, are also being developed in Alaska (and are already in use in many parts of the world). Geothermal energy is the heat energy that comes from the earth itself. Steam and hot water reservoirs can be used directly for electric generation, direct heating, and for carbon dioxide for greenhouses, as is the case at Chena Hot Springs, near Fairbanks (REAP, 2015). Hydropower is the energy produced by moving water — rivers and the ocean. As in other instances, this energy is captured and used to generate electricity and heat. Most of the hydropower in Alaska comes from projects in Southeast.

Traditional uses of solar and wind energy include much more than power. In addition to the ways mentioned above, Alaska Native people have for millennia been using energy sources in ways that some westerners might consider uncommon. "According to oral tradition, the sun is a transformed woman who fled to the skyland while being chased by her brother, who became the moon and continues to pursue her" (Fienup-Riordan and Rearden, 2012, p. 61). Like all other things, people believe that the sun and the wind have animate spirits, and which tell us what to expect from the landscape.

For example, the sun plays an important role in helping people know what to expect from the weather. John Phillip, from Kongiganak, and Paul Kiunya, from Kipnuk, agreed that "dawn shows what the weather will be like during the entire day … They tell us that when the sun rises causing the clouds to turn red, even though the weather is good, it will get bad before day's end. But when the horizon is bright in the morning, the weather might be good all day" (Fienup-Riordan and Rearden, 2012, p. 62–63). Too, when it is going to be very cold, people say that the sun puts on its mittens, as a warning to people of coming temperatures.

Similarly, the winds have the power to indicate what to expect from the ocean and sea ice, as well as the arrival of subsistence animals. If the wind continues for two or three days, people on St. Lawrence Island know to expect sea ice to be blown in. This can be dangerous for hunting, and can make it difficult to bring harvested animals to shore (Krupnik and Jolly, 2002). In the winter, an easterly wind can herald the coming of spring sea mammals; and summer winds might mean that fish are being blown into the rivers (Fienup-Riordan and Rearden, 2012). The wind is also important for knowing whether the weather will be good or bad for fishing. A story told by elders of Tununak recounts how Edward Hooper's grandmother bequeathed a southerly wind to the villagers before she died, "so they could fish during good weather" (Fienup-Riordan and Rearden, 2012, p. 84).

Traditional ways of using energy resources compliment more contemporary uses. While the sun and the wind continue to be faithful companions in indicating what to expect from the weather, they also provide important ways to power our lives. We depend on energy sources for electricity, for heat, and for fuel, as well as for shelter and protection from the elements.

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Vocabulary

research – what people do in order to look for information about something they want to know more about

Activity Preparation

1. Decide how you will group your students. The class will be divided into four groups and each group will be assigned a source of alternative energy to research.
2. Make copies of each group's Student Information Sheet and Student Worksheet, one for each group member. Make copies of the Student Worksheet: Alternative Energy Sources and My Community", one for each student in the class.

Activity Procedure

1. Introduce the vocabulary words research and source. Lead a discussion about why it is important for a scientist to conduct research at the beginning of a project.
2. Explain that they will be conducting research about different types of alternative energy, and for this activity, the source will be fact sheets taken from the Alaska Energy Report.
3. Divide students into groups and distribute the Student Information Sheets and accompanying Student Worksheets. Circulate and assist while the groups complete their worksheets. Explain that they will be presenting their findings to the rest of the class.
4. Review your classroom procedures for presentations. Have each group share the questions and answers from their worksheet with the rest of the class.
5. Distribute the Student Worksheet: Alternative Energy Sources and My Community. Complete the graphic organizer together as a class.
6. Instruct students to consider the information presented and pick an energy source(s) they believe would be a good fit for their community. Have students work individually to write a paragraph about their choice.

Extension Activity

- Invite a local elder or cultural knowledge bearer to visit the class. Ask him or her to discuss the traditional ways people used resources wisely and avoided excess waste.

Answers

Answers will vary.

References

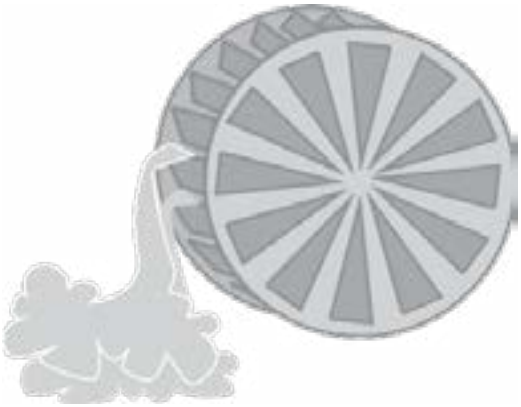
Biomass Energy Centre. (2011). "What is BIOMASS?" Accessed from: http://www.biomassenergycentre.org.uk/portal/page?_pageid=76,15049&_dad=portal

Fienup-Riordan, Ann, and Alice Rearden. (2012). Ellavut: Our Yup'ik World and Weather. Continuity and change on the Bering Sea Coast. Seattle and London: University of Washington Press.

Krupnik, Igor, and Daynna Jolly. (2002). The Earth is Faster Now: Indigenous Observations of Arctic Environmental Change. Arctic Research Consortium of the United States and Smithsonian Institution Presses.

Student Information Sheet
HYDROKINETIC DEVICES

Adapted from Alaska Energy Report



Hydrokinetic devices are powered by moving water. They are placed directly in a river, and they generate power only from the energy of moving water. As water flows downriver, it causes a turbine to spin. The turbine is connected to an electric generator. The amount of hydrokinetic power depends on the speed of the river. This is different from traditional hydropower that uses a dam or some other structure that diverts water to create enough volume and drop to spin a turbine for power generation. Rivers must be fast enough for a hydrokinetic device to work.

The lowest river speed needed to operate a hydrokinetic device is about 2-4 knots (2.3-4.6 miles/hour). The best currents are in the 5-7 knot (5.8-8.1 miles/hour) range. The water also needs to be deep enough to support the device. The best locations in a river are areas of a steady flow, and areas that don't change too much in water level (flooding, long periods of low water). The turbine on a hydrokinetic device is similar to a wind turbine. Because water is 850 times more dense than air, the energy generated by flowing water is much greater than that generated by wind. Also, stream velocity does not change as much as wind velocity. Hydrokinetic devices do not produce greenhouse gases.

Communities in Alaska are studying how these devices work in different environments. One has been used in the Yukon River at the village of Ruby. The community of Eagle also has plans to test a device in the Yukon. Hydrokinetic devices can be bought in Fairbanks. In Alaska, water flow changes with the seasons and the hydrologic cycle. Melting glaciers and seasonal snowfall add a lot of water to Alaska's waterways. Flow rates are usually highest during the spring snowmelt, but these higher levels can also bring trees and ice down the river. In winter, river levels and flow rates drop, and ice may harm the turbine.

To put together a hydrokinetic project, information on the project site must be collected. This process includes collecting information on river flow, depths, and fish data.

Dangers

Some possible dangers for turbines include silt in the river, ice, and floating logs.

Salmon

Adult salmon usually like to swim closer to riverbanks where the water is slower. This is good because they are most likely to stay away from the faster currents where a turbine might be. Young salmon (smolt) though, like to swim in faster flowing waters.

River Navigation

Rivers are an important way to travel in Alaska. How will a hydrokinetic device affect river traffic?

Name:_____

Student Worksheet

HYDROPOWER

1. What is the source of hydropower?_____

2. Does the area around my community have enough of the required source to consider hydropower as an energy source?

   _____

3. Does hydropower have to be converted to another form of energy to be useful in my community?

   _____

   If so, what must be done to make the transformation from the original source?

   _____

4. If there is a source of hydropower for my community, what is the place most likely for a power transformation site?

   _____

   _____

5. Does the site have specific traditional or cultural importance? _____

6. If so, what is it ? _____

7. Does the site have an Alaska Native name? _____

8. How would adding hydropower and its transformation facility affect the way people and animals go about their daily lives in my community?

   _____

   _____

   _____

Name:_____

Student Worksheet

9. What would happen to the level of greenhouse gases sent out by all the community's energy sources if hydropower were part of the energy picture? Explain your answer.

_____

_____

10. Summary: List at least two or three advantages and two or three disadvantages of using hydropower as an alternative energy source in your community.

Advantages:

_____

_____

_____

Disadvantages:

_____

_____

_____

Student Information Sheet

WIND TURBINES

Adapted from Alaska Energy Report

Wind is caused by temperature and pressure changes in the air as the sun warms Earth. Wind pushes against the turbine and causes it to spin a generator for electricity. Wind turbines do not produce greenhouse gases.

Most rural communities that use wind energy use a wind-diesel generator. This is a wind turbine that is connected to a diesel generator. When the wind isn't blowing strong enough to generate electricity, the diesel is burned to make electricity. Most diesel generators are designed to provide power to a load that changes, so connecting them to wind power is not a concern unless the generator is quite old. Changes in wind may make operation of an older generator inefficient. It may need to be replaced.

The best locations to harness wind energy in Alaska is along the coasts and the Yukon-Kuskokwim deltas. Interior Alaska communities also may have wind resources, but the best sites are mostly on hills, ridge tops and passes.

When considering a site for a wind turbine several general criteria must be kept in mind:

- A likely wind resource, the higher the better, must be available.
- Environmental impact must be as limited as possible.
- Accessibility of the site, historical significance and land cost must be considered.
- Closeness of the turbine site to the existing power plant is a consideration.

Concerns about wind energy focus on the turbines' potential impact on birds and wildlife. The impact of very cold temperatures on the turbines' performance and reliability, as well as integrating power generated by wind turbines into older, local diesel power plants are additional concerns.

Name:_____

Student Worksheet

WIND POWER

1. What is the source of wind power? _____

2. Does the area around my community have enough of the required source to consider wind power as an energy source?

   _____

3. Does wind power have to be converted to another form of energy to be useful in my community?

   _____

   If so, what must be done to make the transformation from the original source?

   _____

   _____

4. If there is a source of wind power for my community, what is the place most likely for a power transformation site?

   _____

5. Does the site have specific traditional or cultural importance? _____

6. If so, what is it ? _____

7. Does the site have an Alaska Native name? _____

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Name:_____

Student Worksheet

8. How would a wind power generator(s) affect the way people and animals go about their daily lives in my community?

   _____

   _____

   _____

9. What would happen to the level of greenhouse gases sent out by all the community's energy sources if wind power were part of the energy picture? Explain your answer.

   _____

   _____

10. Summary: List at least two or three advantages and two or three disadvantages of using wind power as an alternative energy source in your community.

    Advantages:

    _____

    _____

    _____

    Disadvantages:

    _____

    _____

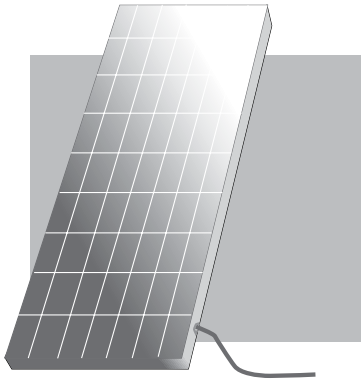
    _____

Student Information Sheet
PHOTOVOLTAIC SOLAR PANEL

Adapted from Alaska Energy Report

Photovoltaic panels are a technology that is used to transform the sun's radiation into electricity. Photovoltaic panels work by placing them in sunlight. They work at any temperature. The use of photovoltaic panels does not produce greenhouse gases.

The amount of solar energy we are able to use depends on the latitude, time of year and the weather. In the northernmost parts of Alaska, there is sunlight up to 24 hours per day in June, but no sunlight in December. Solar energy is most available in summertime, when the need for heat and electricity is the lowest. However, except for the northernmost part of the state, solar energy is usable for seven to eight months of the year.



Two things must be considered for solar energy use in Alaska:

- The amount of sunlight when the energy is needed and
- The cost of other forms of energy.

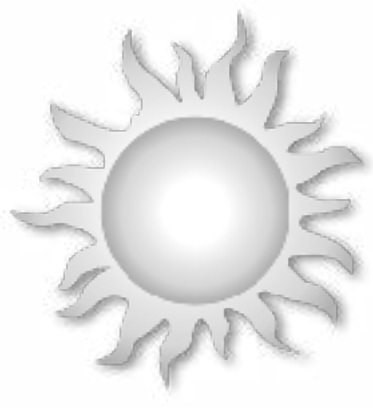
Photovoltaic systems are best for communities that already have electrical storage systems. This helps decrease the cost of panels, and other expensive parts that are needed to make this work.

If electricity cost is now more than $1 per kilowatt-hour, photovoltaic panels may be worth looking into.

Name:_____

Student Worksheet

SOLAR POWER



1. What is the source of solar power? _____

2. Is the solar power source for my community constant? If not, can power be stored?

   _____

   _____

3. Does solar power have to be converted to another form of energy to be useful in my community?

   _____

   If so, what must be done to make the transformation from the original source?

   _____

   _____

4. What is the best site for a solar power plant? _____

   _____

5. Does the site have specific traditional or cultural importance? _____

6. If so, what is it? _____

7. Does the site have an Alaska Native name? _____

Name:_____

Student Worksheet

8. How would building a solar power generator(s) affect the way people and animals go about their daily lives in my community?

_____

_____

_____

9. What would happen to the level of greenhouse gases sent out by all the community's energy sources if solar power were part of the energy picture? Explain your answer.

_____

_____

_____

10. Summary: List at least two or three advantages and two or three disadvantages of using solar power as an alternative energy source in your community.

Advantages:

_____

_____

_____

Disadvantages:

_____

_____

_____

Student Information Sheet
BIOMASS TECHNOLOGIES

Adapted from Alaska Energy Report

Burning carbon-based plant matter creates biomass energy. Wood is the most commonly used form of biomass fuel. It can be used directly as firewood or processed into chips or pellets. Finding, gathering, stacking and storing wood are the initial challenges. Processing biomass ranges from the simple (cutting and stacking) to the complex (drying or compressing chips or pellets) and the cost rises with the level of complexity. The more you have to do with wood to make it burn effectively, the more it costs to burn it. Proper handling and storage of wood are essential to efficient use.

Alaska has nearly 12 million acres of forested land. Some of it has been burned by wildfires or affected by beetles, but much of the wood is still useable. Alaska grows more wood every year than it uses for energy.

Biomass technologies in Alaska fall into three categories:

- Home heating devices like stoves and small boilers
- Community scale heat and/or power systems based on boilers or engines
- Large scale power generators based on steam or wood gas

However, there are many challenges to using wood as a fuel. It costs a significant amount of money to change a coal or diesel fired power plant over to wood fired.

Domestic (home) use heating devices (stoves or small boilers) do not burn wood efficiently and produce air pollution and greenhouse gas emissions. Small community scale heat and power systems are usually based on boilers that convert wood heat to hot water or steam for community distribution. Current technologies available for small community systems are usually quite inefficient, though better ones are in development. Large-scale power generators are usually not suitable for small communities that require only moderate power loads and have limited technical expertise.

Some communities in Alaska have made use of wood in limited capacities. The village of Tanana uses two cordwood boilers to heat water for the washeteria. Craig, Alaska uses a wood-chip burning boiler to heat its school and its swimming pool. Wood chips come from a local sawmill.

Both the Cold Climate Housing Research Center and the United Technologies Corporation in Fairbanks are conducting further research.

Name:_____

Student Worksheet

BIOMASS POWER

There are a number of sources for biomass material (crops grown as fuel—grasses, hybrid willows, sugarcane— biodiesel, some garbage, manure) but the one most readily available near many Alaska communities is wood. Wood's potential energy could heat homes directly or could create steam to turn a turbine and power a generator to make electricity.

1. Is there a large source of wood near my community? _____

2. Many people burn wood to heat their homes. What two things could be done to make wood burning more efficient?

   _____

   _____

3. Wood could be used as an alternative fuel for generating electricity. What changes would have to be made to the way that electricity for my community is made today? List at least two.

   _____

   _____

   _____

4. If wood were to be used as an alternative source to generate electricity, the amount of wood to be cut would increase. How might the animal life around my community be affected?

   _____

   _____

5. How might changes in the forest around my community affect traditional ways of community life?

   _____

   _____

Name:_____

Student Worksheet

6. What would happen to the level of greenhouse gases sent out by all the community's energy sources if wood power were a greater part of the energy picture? Explain your answer.

   _____

   _____

   _____

7. Summary: List two ways that wood burning for heating could be made more efficient.

   _____

   _____

8. List at least two or three advantages and two or three disadvantages of using wood as an alternative energy source to generate electricity in your community.

   Advantages:

   _____

   _____

   _____

   Disadvantages:

   _____

   _____

   _____

Name:_____

Student Worksheet

ALTERNATIVE ENERGY SOURCES AND MY COMMUNITY

Use this worksheet to record information about four alternative energy sources and list any ideas you have about each source's possible use in your community. A sample is shown.

Alternative Energy Source	When is it Available?	How its Energy is Transformed	Contribution to Pollution	Requirements for Use	Can it be Used in My Community?
Cogeneration: capture waste heat from a generator. A diesel generator produces about 32% electricity and 68% heat. The heat is often wasted.	☐ All year ☐ Summer ☐ Winter ☐ Never	Heat is captured and piped to another building for heating.	Emissions are slightly decreased overall as heating requirements in other buildings are met by captured waste heat and less fuel is burned.	Current generator has to be converted so that extra heat can be captured. Pipes must be constructed to carry the heat to another building.	Costs a lot but could be done. A few buildings might be able to be heated.
Hydro Energy: use local water sources to generate power.	☐ All year ☐ Summer ☐ Winter ☐ Never				
Biomass Energy: use wood to generate heat and power.	☐ All year ☐ Summer ☐ Winter ☐ Never				
Solar Power: capture the sun's energy.	☐ All year ☐ Summer ☐ Winter ☐ Never				
Wind Energy: use the energy of the wind to generate power.	☐ All year ☐ Summer ☐ Winter ☐ Never				

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Name:_____

Student Worksheet

The PLAN: On the following lines write the energy source or sources you think will make the best addition(s) to your community.

_____

_____

_____

_____

_____

_____

In the space remaining write a paragraph that explains the choice(s) you have made. Your paragraph should begin with the phrase "I think_____would be the best energy source for my community because_____" and go on from there. By the time you finish your paragraph you will have a good summary of your ideas about alternative energy sources for your community. You are ready to share your ideas with your classmates and your community.

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Name:_____

Student Worksheet

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