COMMUNITY ENERGY USE

Overview:

Students will investigate change in the way their local community has used energy over time, including the types of energy used, their sources, and the cost involved.

Objectives:

The student will:

- compare energy use before Western contact with energy use in a modern community;
- investigate the current cost of fuel as applied to community energy needs; and
- play a game to simulate the calculations needed to interpret heating degree days.

Targeted Alaska Grade Level Expectations:

Science

[7] SA1.2 The student demonstrates an understanding of the processes of science by collaborating to design and conduct simple repeatable investigations in order to record, analyze (i.e. range, mean, median, mode), interpret data, and present findings.

[8] SA1.2 The student demonstrates an understanding of the processes of science by collaborating to design and conduct repeatable investigations in order to record, analyze (i.e. range, mean, median, mode), interpret data, and present findings.

[7] SB2.1 The student demonstrates an understanding of how energy can be transformed, transferred, and conserved by explaining that energy (i.e. heat, light, chemical, electrical, mechanical) can change form.

[8] SB2.1 The student demonstrates an understanding of how energy can be transformed, transferred, and conserved by identifying the initial source and resulting change in forms of energy in common phenomena (e.g. sun to tree to wood to stove to cabin heat).

[8] SF1.1-3.1 The student demonstrates an understanding of the dynamic relationships among scientific, cultural, social, and personal perspectives by describing how local knowledge, culture, and the technologies of various activities (e.g. hunting, fishing, subsistence) influence the development of scientific knowledge.

Vocabulary:

electricity – the collection of physical effects resulting from the existence of charged particles, especially electrons and protons, and their interactions; the electric current generated by the flow of electrons around a circuit and used as a source of power

energy – the ability to do work; energy can exist in a variety of forms (electrical, mechanical, chemical, radiant, gravitational, thermal, or nuclear) and can be transformed from one form to another

fuel – a substance that produces useful energy when it undergoes a chemical or nuclear reaction; fuel such as coal, wood, oil or gas provides energy when burned

heat – a form of energy produced by the motion of molecules; the heat of a substance is the total energy produced by the motion of its molecules

heating degree day (HDD) – quantifiable measurement of the energy needed to heat a home or business; a structure earns one heating degree day for each degree that the daily mean temperature is below 65°F

insulate – to cover or surround with a material that prevents the loss or transfer of heat, electricity or sound

light – a form of electromagnetic energy that can be perceived by the human eye; made up of electromagnetic waves that travel at a speed of about 186,282 miles per second

Whole Picture:

Almost all of the energy that drives Earth's systems radiates from the sun. The sun's energy powers the hydrological cycle, climate and photosynthesis. Prior to Western contact, nearly all of the energy needs of the

COMMUNITY ENERGY USE

Indigenous people of Alaska were met directly by the sun. Food, fuel (biomass), building materials, clothing and tools were all directly attributable to solar energy.

Today, most of Alaska's energy needs are supplied by burning fossil fuels such as oil and coal. Other sources include: hydroelectric, geothermal, solar, wind and tidal. One way scientists quantify energy use in a community or region is through heating degree days (HDD). HDD calculates community energy use by measuring the energy needed to maintain a home or business at 65°F.

The formula used to determine a community's HDD uses the average temperature on a given day and subtracts it from 65°F. If the value is less than or equal to zero, that day has zero HDD. The sun's energy has kept the structure warm. A positive value becomes the HDD for that day. For example, an average December day in Fairbanks is about -15°F.

To calculate the HDD for that day: 65°F – (-15°F) = 80°F. The HDD is 80.

HDD can be added over periods of time to provide an estimate of seasonal heating requirements for a building, village, or region. For example, over the course of a heating season the HDD for New York City is 5,050 whereas the HDD for Barrow is 19,990. Using the HDD one can conclude that a home of comparable structure and insulation would require four times the energy to heat in Barrow when compared with New York City. A similar home in Los Angeles, CA (whose HDD for the season is only 2,020) would require even less energy. However, a home in Los Angeles might require more energy when comparing cooling degree days (CDD), a measurement of the energy required to cool a house to 65°F.

Materials:

- Highlighter
- Dice (8-sided); two different colors per pair of dice (one pair of dice per pair of students)
- Penny (one per pair of students)
- TEACHER INFORMATION SHEET: "Comparing Then and Now"
- STUDENT INFORMATION SHEET: "Building a Sod House"
- STUDENT WORKSHEET: "Comparing Then and Now"
- STUDENT WORKSHEET: "Scorecard"
- STUDENT WORKSHEET: "Community Survey"
- STUDENT WORKSHEET: "Energy Words Vocabulary"

Activity Preparation:

1. Contact local businesses to let them know that students will be calling for information. For STUDENT WORKSHEET: "Community Survey" students will be asking about the amount of gasoline, heating fuel, diesel (for generation of electricity) and electricity used by the community each year.
2. For STUDENT WORKSHEET: "Comparing Then and Now" students will need to know the price of various energy resources. Find out the current cost of local fuel ahead of time so you can help students fill in the column. Consider heating fuel, propane, gasoline, kerosene, diesel and electricity.
3. Find out the approximate heating degree days for your community by visiting the Cold Climate Housing Research Center at: http://www.cchrc.org/climate-information. Bookmark the site. Also find NOAA's National Climatic Data Center at: http://www.ncdc.noaa.gov/asos/index.php

Activity Procedure:

1. Hand out STUDENT INFORMATION SHEET: "Building a Sod House" and read aloud as a class. Allow time for students to share their own related knowledge and experiences.
2. Pass out STUDENT WORKSHEET: "Comparing Then and Now." Ask students to work in pairs to fill out page one. Review what "before Western contact" means, if needed. Give them five minutes to work on it, then discuss the answers as a class. Tell students to fill in missing information as students share answers. Refer to TEACHER INFORMATION SHEET: "Comparing Then and Now" for notes.
3. Ask students to begin page two of the worksheet. While they are working, write the local price for fuel sources on the board (see Activity Preparation). When students finish the worksheet, discuss the following:

a. Compare pages one and two. What comes to mind?
b. Prior to Western contact, the cost of fuel was related to the labor involved. Modern conveniences make life more comfortable, but are very expensive. Are all modern ways of life worth the expense? Why or why not?
c. How could you incorporate traditional ways of life with modern life to save fuel costs?
d. Before Western contact, was the community self-sustainable? (Define sustainable if needed.)
e. Could the community be self-sustainable now? What would happen if no more fuel was delivered?

4. Show students the bookmarked websites for the Cold Climate Housing Research Center and NOAA's National Climatic Data Center (see Activity Preparation). Discuss heating-degree days. (Refer to Whole Picture for more information.) Do some examples on the board that will aid students in the game to follow. Be sure to include negative numbers to represent temperatures below 0° F. Emphasize that any number 65 or above is automatically a zero heating degree day.
   a. Divide students into pairs. Give each a pair of 8-sided dice (each die should be a different color), one penny, and a copy of STUDENT WORKSHEET: "Score Card." Explain the rules as follows:
   b. Each player will take turns rolling the dice to find a temperature and flipping the penny to determine if it is above or below zero. One die is the first number in the temperature, the other die is the second number. If the penny is heads, the temperature is positive, if it is tails, the temperature is negative. Once they determine the temperature, they must compare it to 65° F to determine the heating-degree days. Anything rolled above 65° F is a zero.
   c. Once students have completed their scorecards and tallied the number of heating degree days at the bottom, ask students to determine what the high score and the low score means.
   d. Have students line up in order of their number of heating degree days they calculated, lowest to highest. Ask them which end represents a location closest to the equator? The north pole?

   Extension Idea: Look at a map of North America. Ask the person with the highest number to choose a town located at a high latitude. The person with the lowest number should choose a location at a low latitude. Have the students figure out a location in between that matches their HDD calculation.

5. Hand out STUDENT WORKSHEET: "Community Survey: Energy Use in My Community." Go over the directions with students. As they read down the list of fuel types on the left-hand side of page one, have students highlight the box if the community uses that type of fuel. Students will only fill in information about highlighted fuel. Students will need to research the missing information (including the questions on page 2 about electricity). To do this, teachers need to determine the best approach for their class and community.
   - Teachers can find out the information ahead of time and write it on the board or on a handout.
   - Students can work in pairs or groups to find out information and share with each other. This would require access to telephone books, telephones, and the Internet during class time.
   - The worksheet can be given as an individual homework assignment.
   - The teacher can assign individual students to find out one piece of information, then report back to the entire class.

6. Once students have completed the STUDENT WORKSHEET: "Community Survey: Energy Use in My Community," have a class discussion about the information learned. Consider the following questions:
   a. What did you learn about energy use in your community? What surprised you?
   b. Do you think that fuel costs are the same in every community? Why or why not?
   c. How is electricity generated in other communities around the state and around the world?
   d. What would happen to your community if the fuel required to generate electricity was no longer available?
   e. Is alternative energy (solar wind, tidal, geothermal, hydroelectric) being used in your community?
   f. What kinds of alternative energy sources does your community have access to?

7. Hand out STUDENT WORKSHEET: "Energy Words Vocabulary" and ask students to complete in class or as homework.

Language Links:

Alaska Native people have always been careful observers of the weather. Their languages are rich in words describing weather. Ask a local Native language speaker to provide the words in the local dialect for the weather phenomenon listed in the chart below. The local dialect for these words may differ from the examples provided. Share the words with students to build fluency in local terms related to weather. Include local words in songs, stories and games when possible.

English	Gwich'in	Denaakk'e	Lower Tanana	Deg Xinag	Your Language
Fuel / gas	Chuu daak'a'	Gaas	Gasr	Xa	
Warm	Gwiindhaa	Høleł		Xedhił	
Cold	Gwiink'oo	K'ekk'øtl	Dli	Izre	

Answers:

STUDENT WORKSHEET: "Comparing Then and Now"

Answers will vary.

STUDENT WORKSHEET: "Community Survey"

Answers will vary.

STUDENT WORKSHEET: "Energy Words Vocabulary"

1. A. and B.
2. B. and C.
3. A. and B.
4. A. and C.
5. A. and B.
6. B. and C.
7. A. and B.
8. A. and C.

COMPARING THEN AND NOW

The STUDENT WORKSHEET: "Comparing Then and Now," asks students to compare ways of life prior to Western contact with current, more modern communities. There are no set answers. The exercise is intended to get students thinking. Below are some things to consider while leading the class through the exercise.

Prior to Western contact nearly all of the energy needs of the indigenous people of Alaska were met directly by the sun. (Ultimately, almost all energy that drives Earth's systems radiates from the sun.) All sources of food, fuel (biomass), building materials, clothing and tools were directly related to solar energy.

As students are contemplating the fuel (energy source) and cost for the section titled "Energy Use: Before Western Contact," there will be a variety of answers. For example, under Travel, students could list walking. Fuel could be manpower or students may get more specific and list food as the source of human energy. These are both correct. Students may speculate about the cost of labor and time (gathering food). These are all good ideas to list, for comparison with modern times.

Here are some ideas to get you started on the chart:

Before Western Contact	**Modern Community Life**
Travel (land and water): walking, dog sled, boat (oars)	***Travel (land and water):*** walking, dog sled, boat (oars), motor boat, car, snow machine, ATV, airplane, train
Cutting wood: axes, handmade cutting tools	***Cutting wood:*** axes, saws, chainsaws, lumber mills, power tools, table saw
Light: oil lamps, sun, fire	***Light:*** sun, electricity, lamps, lights, candles
Heat: sun, fire, body heat, warm clothing	***Heat:*** sun, furnace, wood stove, generator
Home insulation: sod, dirt, snow (in winter), moss, animal hide	***Home insulation:*** foam, fiberglass
Food storage: dried food, permafrost, buried food	***Food storage:*** refrigerator, freezer, dried (cupboards), canned

BUILDING A SOD HOUSE

by Chief Robert Charlie

Let us go back to the ancestral times of Athabascan People when there was no such building material as is available nowadays.

To build a sod house, say 15' by 15' round structure, you must first gather your materials.

Athabascans always carried hand-made tools with them when moving in small groups, for cutting and digging. In this case tools were made of bones or obsidian.

Laying the foundation is digging dirt two or three feet deep for a 15' x 15' family-sized house.

The wall frame is spruce or willow eight to ten feet long and three inches in diameter at the trunk. The poles would be four to six inches apart all the way around. The house is built like a tepee, seven to eight feet high with a hole in the upper center so the smoke can go out.

Around the frame they wrap birch bark or dried and oiled caribou hide.

Once the hide is up they would put dirt and moss on the outer part of the walls. They put extra dirt around the skirt of the sod house.

The door would be of bear hide with full fur.

Once the sod house is completed, there is no draft coming in and it makes it very comfortable. The fire in the center makes for a bright light and is used for cooking.

Directions: Use the box below to draw a sod house like the one described by Chief Robert Charlie. Be sure to use and label each of the parts in the materials list.

Materials List:

- Foundation
- Spruce or willow poles (8-10 feet long & 3 inches in diameter)
- birch bark or oiled caribou hide
- dirt and moss
- bear hide

NAME: _____

COMPARING THEN AND NOW

Energy Use: Before Western Contact

Travel (land and water):	*Fuel required:*	*Cost:*

Cutting wood:	*Fuel required:*	*Cost:*

Light:	*Fuel required:*	*Cost:*

Heat (for homes):	*Fuel required:*	*Cost:*

Home insulation:	*Fuel Required:*	*Cost:*

Food storage:	*Fuel required:*	*Cost:*

NAME: _____

COMPARING THEN AND NOW

Energy Use: Modern Community Life

Travel (land and water):	*Fuel required:*	*Cost:*

Cutting wood:	*Fuel required:*	*Cost:*

Light:	*Fuel required:*	*Cost:*

Heat (for homes):	*Fuel required:*	*Cost:*

Home insulation:	*Fuel Required:*	*Cost:*

Food storage:	*Fuel required:*	*Cost:*

NAME: ______________________________

SCORECARD

Directions: Take turns rolling the dice and tossing the penny to find a temperature; one die is the first number and the other die is the second. If the penny is heads, the temperature is positive, if it is tails, the temperature is negative. Once you determine the temperature, you must subtract it from 65° F to determine the heating-degree days (HDD).

- Anything rolled above 65° F is an automatic zero.
- Don't forget to make your number negative if your penny lands on tails by adding a minus sign (–).

Partners help find the HDD and check work.

________ (Color 1)	=	First Number
________ (Color 2)	=	Second Number
HDD	=	Heating Degree Days
Heads	=	Positive (+)
Tails	=	Negative (-)

Player 1:					**Player 2:**				
Base Number 65˚F		+/– ______ (Color 1) ______ (Color 2)		**HDD**	**Base Number 65˚F**		+/– ______ (Color 1) ______ (Color 2)		**HDD**
65	**–**	_____ _____	**=**		**65**	**–**	_____ _____	**=**	
65	**–**	_____ _____	**=**		**65**	**–**	_____ _____	**=**	
65	**–**	_____ _____	**=**		**65**	**–**	_____ _____	**=**	
65	**–**	_____ _____	**=**		**65**	**–**	_____ _____	**=**	
65	**–**	_____ _____	**=**		**65**	**–**	_____ _____	**=**	
65	**–**	_____ _____	**=**		**65**	**–**	_____ _____	**=**	
65	**–**	_____ _____	**=**		**65**	**–**	_____ _____	**=**	
65	**–**	_____ _____	**=**		**65**	**–**	_____ _____	**=**	
65	**–**	_____ _____	**=**		**65**	**–**	_____ _____	**=**	
65	**–**	_____ _____	**=**		**65**	**–**	_____ _____	**=**	
			Total HDD					**Total HDD**	

NAME: _____

COMMUNITY SURVEY

Energy Use In My Community

Directions: Using the chart below, investigate the way energy is used by your community. Find information by talking to family and friends and using the phone book and Internet. You may need to make some phone calls to get your questions answered.

Which of the following types of fuel does your community use? Highlight each one.	For each item highlighted, fill in the information below.		
	What business sells this product?	How does it get to your community?	How much is used in one year?
Kerosene	 Phone:		
Diesel	 Phone:		
Heating fuel	 Phone:		
Gasoline	 Phone:		
Propane	 Phone:		

NAME: _____

COMMUNITY SURVEY

Where does the community's electriciity come from?	What things in the community are dependent on electricity?	How many kilowatts of electricity does the community use each year?
What fuel generates it?		How many kilowatts of electricity does an average home use each year?

Refer to page one of this worksheet and page two of the STUDENT WORKSHEET: "Comparing Then and Now." Calculate yearly energy costs for your community.

What is the current price per gallon for diesel? _____

How many gallons of diesel are used by the community each year? _____

Calculate the cost: $_____ (price per gallon) x _____ (gallons per year) = $_____ (cost for one year)

How many kilowatts of electricity does the community use each year? _____

How much electricity does an average home use in one year? _____

About how many homes are there in your community? _____

Calculate: _____ (number of homes) x _____ (average use) = _____ (kilowatts used by homes in a year)

NAME: _____

ENERGY WORDS VOCABULARY

Directions: Next to each word are two true statements and one false statement. Read through then cross out the one that is false.

1.	energy	A. the ability to do work B. usable heat or power C. the time it takes to walk a mile
2.	heat	A. how far a hot air balloon can travel B. a form of energy C. produced by the motion of molecules
3.	energy transfer	A. one form of energy can transform into another B. solar energy can be stored then used to create electricity C. a fuel truck makes a delivery
4.	fuel	A. provides useful energy when it undergoes a chemical or nuclear reaction B. the left-over debris after a campfire C. coal, wood, oil and gas that provide energy when burned
5.	electricity	A. the current generated by the flow of electrons around a circuit B. used as a source of power C. named after a show on PBS
6.	light	A. travels at the speed of sound B. a form of electromagnetic energy perceived by the human eye C. travels in waves at a speed of 186,282 miles per second
7.	insulate	A. to cover or surround to prevent heat loss B. to cover or surround to prevent heat transfer C. to cover or surround with heat
8.	heating degree day	A. a measurement of the amount of energy needed to heat a home B. the amount the temperature goes up in one day C. based on a base temperature of 65˚F