

EDUCATIONAL MODULE

COMPARISON OF HOME ENERGY USE ACROSS THE UNITED STATES

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TITLE: Comparison of Home Energy Use Across the United States

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GRADE LEVEL/SUBJECT: 6th – 8th Science, Geography

CURRICULUM STANDARDS: (from the National Science Education Content Standards)

Science as Inquiry Standard A: Use appropriate tools and techniques to gather, analyze, and interpret data; Develop descriptions, explanations, predictions, and models using evidence; Think critically and logically to make the relationships between evidence and explanations.

Physical Science Standard B: Transfer of energy – energy is a property of many substances and is associated with heat, light, and electricity. Energy is transferred in many ways.

Science and Technology Standard E: Identify appropriate problems for technological design.

OVERVIEW:

This activity uses a computer database to quantify information on energy use in homes and to give information on improvements that could be made in homes to lower their energy use. The database could be used in several ways. It provides good information on an individual homes energy usage. It gives potential improvements with their anticipated cost, energy use and payback time. The focus of this activity is to use the database to compare one home style in various locations around the U.S. and the energy differences that would be due to climate. Feel free to change the focus of the activity to fit your class and purposes.

PURPOSE:

To increase the students awareness of energy use and efficiency in homes

To apply knowledge of energy use and efficiency to real life situations

To compare climate differences and their impact on energy use

LEARNING OBJECTIVES:

Students should be able to discuss what effects energy efficiency in homes, how climate influences energy use, and make suggestions for improvements to a home for a sample climate.

VOCABULARY:

Energy, energy efficiency, fuel, kWh, Therm, Energy Star label, upgrade, climate

RESOURCES AND MATERIALS:

Handouts, almanacs for zip codes and climate information, computers for web access to <http://hit.lbl.gov>

PREPATORY ACTIVITIES AND PREREQUISITE KNOWLEDGE:

Students should know about different climate zones in the U.S., what energy is and how it is used in a home.

ACTIVITY TIME PERIOD:

As little as two 45-minute periods, easily extended over more time.

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TEACHER SCHEDULE:

DAY ONE

1. Quickly review what climate is and different climates in the U.S.
2. Quickly review what uses energy in a home.
3. Break students into groups of four. Hand out the worksheet. Have the students choose 4 different climate zones to compare and find the data in the almanac for the worksheet data chart under part one.
4. After groups have completed part one of the worksheet, give the group a Home Improvement Tool Worksheet. Have the group decide on the type of home statistics they want to test for part two of the worksheet. (The teacher could use data from a real home in the local area. If this is the case, go over the data with the students so they understand the type of parameters.) Give the students the fuel cost data so the class uses the same values. You can pull this off the website for your zip code.
5. Students need to be ready to input information in the computer for day two.

DAY TWO

1. Meet in the computer lab.
2. Have the students record their hypothesis for part three of the worksheet.
3. Each student in the lab group inputs the information for one climate (using the zip code for the climate) and all use the same house information. Students record the data on the data sheets for all four climates their group worked with.
4. Students need to answer the conclusion questions.
5. Discuss results as a class if not doing the optional day three.

OPTIONAL DAY THREE – EXTENSION AND CHALLENGE

1. As a lab group, the students should hypothesize what changes in the home would make the biggest difference for each climate. (i.e., no windows on the south side in Arizona, eliminate a swamp cooler in a humid climate, etc.)
2. Test the changes by entering the data in the computer again. Did the change help the energy usage?
3. Have students share the findings with the class.

ADDITIONAL EXTENSIONS

1. Have students run the program with their own home information. They could then look at specific upgrades (improvements) that could be done to their home, analyze the cost of those upgrades, and the payback period of those costs.
2. Have students change other variables such as the direction the home faces, the type of heating or cooling equipment, or the type of energy being used. Change only one variable at a time.
3. Take a field trip to a store to look at appliances and how they are marked for energy efficiency.
4. Study alternative energy sources and how those could lower energy costs.

NAME _____

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Background: This lab will be investigating the differences that occur in energy use in a home because of the location of the home in the United States. These differences could be a result of energy costs, but also could be related to climate. You will be comparing the same structure in several different climatic regions by using a computer simulation program.

Problem: What will happen to the cost of energy for a home if we placed the home in a different climate?

Hypothesis: What do you think would happen to the cost of energy for a home if we compared a home in a hot, wet climate to a home in a cold, dry climate?

Part one- Climate Information

Procedure:

1. In your lab group, choose 4 different types of climate within the U.S.
2. Use an almanac to find information on these types of climate to fill in the following chart.

Data Chart for Climate Information

	1	2	3	4
Climate Name				
Climate Description				
Sample location				
Zip code				
Average Low Winter Temperature				
Average High Summer Temperature				
Average Rainfall				
Average Days of Sunshine				

Part Two- Home Information

Procedure:

1. Get a Home Improvement Tool Worksheet from your teacher.
2. As a lab group, decide from the choices given what will represent your study home. You could test a very modern home with all new appliances, or you could do an older home with old appliances. The group must agree on each question. Get the fuel costs from your teacher.
3. Check your choices with your teacher. These will be the choices that you will enter on the computer database tomorrow for all four climatic regions.

Part Three- Comparison

- Hypothesis:** a. Which of the climate zones you chose will have the lowest energy costs for the home? Why? _____
- b. Which of the climate zones you chose will have the highest energy costs for the home? Why? _____

Procedure:

1. Each member of the team will enter the information for the house under one of the four climate types by using the zip code for one location in that climate type. Everyone will then record the information on his or her own chart.
2. Bring up the following site on the computer: <http://hit.lbl.gov/>
3. Enter the zip code for your climate zone.
4. Enter the data for your house where asked. When asked for which direction the front of the home faces enter "SOUTH".
5. When asked if you want to put in actual utility bill information type "NO".
6. Once the program processes the information, enter the results in the following data chart.
7. Answer the conclusion questions.

Data Chart for Annual Energy Use of the Home

	1	2	3	4
Session Number				
Zip code				
Climate Name				
Annual Energy Cost for Home				
Annual Energy Cost with Upgrades				
Potential Savings				
Heating				
Water Heating				
Appliances				
Lighting				
Miscellaneous				
Types of Upgrades				

Conclusion Questions:

1. Were there any differences in the annual energy cost for the home in different climate regions? Explain.

2. Compare the highest cost energy home location to the lowest cost energy home location.
 - a. In what area was the greatest difference of energy use (heating, appliances, etc.)?

 - b. In what area was the least difference of energy use?

 - c. Was there a difference in the amount of Potential Savings for the houses?

3. Using your data for the climate, explain the difference of annual energy costs.

4. Did each climate have the same type of upgrades or did they differ by location? Explain your answer in terms of climatic differences.

5. How accurate was your hypothesis? Explain what you would answer now with your new knowledge.

6. What would you look for in a house that you were considering purchasing if you wanted to have low energy bills?

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Extension and Challenge:

The next step for this lab is to determine what changes in the home would make the biggest difference in energy costs for each climate. The changes could be some of the upgrades suggested by the program, or they could be changes in the structure of the house. As a group, decide what changes you will make to improve the energy costs for each climate. Document those changes in a chart, run the program with those changes and see if the results are lower energy costs. If your changes are upgrades, input the session number to make those changes. If your changes are to the house structure, then run a new set of information. Share your findings with the class.

Choose the parameters for the house you want to test.

1. When was your house built? ___pre 1960; ___1960's; ___1970's; ___1980's; ___1990's
2. How many stories above ground is your house? ___1; ___2; ___3
3. How many occupants are there in each age group?
 - a. Age 5 and under _____
 - b. Age 6 – 13 _____
 - c. Age 14 – 64 _____
 - d. Age 65 + _____
4. What are your fuel prices? (Get this from your teacher)
 - a. Electricity \$ _____/kWh
 - b. Piped natural gas \$ _____/therm or 100 cubic foot
 - c. Liquid propane gas \$ _____/gallon
 - d. Fuel oil \$ _____/gallon

Structure:

5. What type of foundation do you have?
 - a. _____slab
 - b. _____unfinished basement
 - c. _____finished basement
 - d. _____unvented crawlspace
 - e. _____vented crawlspace
6. What is the square footage of your home? ___2000 sq. ft. ___
7. Is your house insulated?
 - a. Walls: ___yes; ___no; ___I don't know
 - b. Floors: ___yes; ___no; ___I don't know
 - c. Ceiling: ___yes; ___no; ___I don't know
8. What is the most common type of window in your house?
 - a. Frames: ___metal; ___wood/vinyl; ___I don't know
 - b. Panes: ___1; ___1 and storm; ___2
9. What portion of each side of your house is glass, including windows and glass doors:
 - a. front: ___none; ___5%; ___10%; ___15%;
___25%; ___50%; ___75%; ___all
 - b. right: ___none; ___5%; ___10%; ___15%;
___25%; ___50%; ___75%; ___all
 - c. back: ___none; ___5%; ___10%; ___15%;
___25%; ___50%; ___75%; ___all
 - d. left: ___none; ___5%; ___10%; ___15%;
___25%; ___50%; ___75%; ___all

Heating and Cooling:

10. What is the main source of heat in your home? (you may check more than one)
 - a. ___none or wood heat
 - b. ___central (ducted) gas furnace
 - c. ___room (non-ducted) gas furnace

- d. ___ propane (LPG) furnace
 - e. ___ oil furnace
 - f. ___ electric furnace
 - g. ___ electric heat pump
 - h. ___ electric baseboard heater
 - i. ___ gas boiler
 - j. ___ oil boiler
11. What is the main source of cooling in your home? (you may check more than one)
- a. ___ Central A/C
 - b. ___ Ceiling/portable fans
 - c. ___ Electric heat pump
 - d. ___ Room A/C
 - e. ___ Whole house fan
 - f. ___ Swamp cooler
 - g. ___ None
12. Do you use a thermostat to adjust the temperature at night or when you are away?
- a. ___ no
 - b. ___ yes, manual thermostat
 - c. ___ yes, programmable thermostat
 - d. ___ yes, with Energy Star programmable thermostat

Appliances:

13. Describe your water heater. ___ natural gas; ___ electric;
 ___ fuel oil; ___ propane gas
 Purchase year: ___ before 1990; ___ 1990 and later
14. Describe your appliances.
- a. Refrigerator: ___ pre 1980; ___ 1980-1986; ___ 1987-1992; ___ 1993-2000
 - b. 2nd refrigerator: ___ pre 1980; ___ 1980-1986; ___ 1987-1992;
 ___ 1993-2000
 - c. Stand-alone freezer: ___ pre 1980; ___ 1980-1985; ___ 1986-1988;
 ___ 1989-1992; ___ 1993-2000
 - d. 2nd Stand-alone freezer: ___ pre 1980; ___ 1980-1985; ___ 1986-1988;
 ___ 1989-1992; ___ 1993-2000
 - e. Dishwasher: ___ pre 1993; ___ 1993 and after
 - f. Clothes washer: ___ pre 1993; ___ 1993 and after
 - g. Clothes dryer fuel used: ___ electric; ___ natural gas or propane
15. Describe three of your highest use lighting fixtures and the average hours used.
- a. ___ ceiling track lights - ___ <2; ___ 2-4; ___ 5-9; ___ >9
 - b. ___ ceiling surface fixture - ___ <2; ___ 2-4; ___ 5-9; ___ >9
 - c. ___ outdoor light - ___ <2; ___ 2-4; ___ 5-9; ___ >9
 - d. ___ cabinet light - ___ <2; ___ 2-4; ___ 5-9; ___ >9
 - e. ___ floor lamp - ___ <2; ___ 2-4; ___ 5-9; ___ >9
 - f. ___ table lamp - ___ <2; ___ 2-4; ___ 5-9; ___ >9
 - g. ___ recessed light - ___ <2; ___ 2-4; ___ 5-9; ___ >9

Rubric for Comparison of Home Energy Use Across the United States

	Excellent Work	Satisfactory Work	Unsatisfactory Work
Lab Group Work	takes leadership within group, allows all to give input, participates well	participates in group most of time, allows others to give input, gives some input	does not participate with group, does not give any positive input to group
Hypothesis	gives a hypothesis in a complete sentence	gives a hypothesis, may not be in complete sentence	does not answer
Data Collection	fills out all requested data neatly, completes charts correctly, is accurate in collecting data and following procedure	fills out data and follows procedure, not as accurate or neat as is possible for student	leaves blanks in data, does not follow procedure correctly
Conclusion Questions	answers all questions fully and in complete sentences, thoughtful answers, and comes up with new questions to pursue	answers questions, does what is asked but not in any detail	does not answer all questions or incomplete answers
Discussion of Results	able to describe what was done in the lab and the results, what possible errors are and what should be tested next	can find information that was worked on to show and describe, does not fully understand so can not come up with errors or next tests	not able to describe what the lab was or the results