Reading Utility Meters

Students observe and interpret daily and weekly patterns of energy consumption by reading utility meters.

Grade Level: 5–8 (9–12)

Subject Areas: English Language Arts, Family and Consumer Science, Mathematics, Science, Technology Education

Setting: Classroom, home, school

Time:
Preparation: Two hours to 2 days
Activity: Two days to 2 weeks

Vocabulary: Cubic foot, Kilowatt-hour, Meter, Meter reader, Therm

Major Concept Areas:

- Consumption of energy resources
- Quality of life

Getting Ready: See also **Considerations for Conducting Activity** after **Extensions**. Electric and natural gas meters may be available from the school's science department or a local utility. Students can also measure the energy use of various appliances with a watt meter. By plugging a meter into an outlet and then plugging an appliance such as a refrigerator into the meter, students can measure energy use and energy cost for the refrigerator. Watt meters may be available from your local utility or local public library.

You may want to give students copies of ***Meter Locations and Close-Ups*** to help them find their meters. You may want to contact your local utility regarding their rules for reading meters.

Objectives

Students will be able to

- read and interpret information from electric and natural gas meters; and
- compare how energy is used during the day or week to activities and routines at home or at school.

Rationale

Observing and interpreting energy consumption patterns by reading utility meters makes students aware of how they use energy and may lead to strategies that can help them effectively manage energy use in the future.

Materials

- Copies of the following pages:
  - ***Meter Locations and Close-Ups***
  - ***How to Read Electric Meters***
  - ***How to Read Natural Gas Meters***
  - ***Observing Daily Meter Readings*** (see **Considerations for Conducting Activity**)
- Watt meter (optional; see **Getting Ready**)
- Actual utility meters (optional; see **Getting Ready**)
- Graph paper (one or two sheets per student)
- Find additional resources related to this activity on keepprogram.org > Curriculum & Resources

Background

While walking by a house or building, you will often encounter small pieces of equipment encased in glass and metal, mounted on or placed near building walls. If you pause and look closely, you may see four or five circular dials with pointers aimed at clock-like numerals. Perhaps a flat metal plate with ruler-like markings is also inside, spinning quickly. Or you may see a digital display that looks like the numerals on your digital clock or DVD player. This equipment is not keeping time, but it seems to

be measuring something all the time.

What you are looking at is a utility meter. Despite their modest size, utility meters are very important parts of the electric and natural gas utility system. They are reliable pieces of equipment that accurately measure the electricity and natural gas people use every day, even in extreme weather conditions. So dependable are utility meters that we take them for granted. Without reliable meters, a utility would not stay in business very long.

To understand why meters are important, consider the role of measurement in buying and selling goods and services. The prices of all goods and services have units of measure attached to them. Units of measure allow buyers to know how much they get for the price they pay. Familiar examples include the price per pound for potatoes, the cost per foot for lumber, or the price per hour that a plumber charges for labor. To ensure that these units are accurate and consistent, many kinds of measuring equipment and methods have been developed. For instance, a scale is used for weighing potatoes, a tape measure is used for measuring the length of lumber, and the plumber's wristwatch is used for keeping track of time spent on the job. Energy also has to be measured in order for it to be sold. Meters measure the amounts of electricity and natural gas customers use, so the utility can charge them correctly.

Electrical meters measure electricity use in kilowatt-hours, a unit of energy that combines a unit of power (kilowatts) with a unit of time (hours). One kilowatt-hour (kWh) of energy is equal to the energy output of ten 100-watt light bulbs turned on for one hour. Natural gas meters, however, do not directly measure the amount of energy in the gas that the customer uses. Instead, they measure the volume of the gas in units of hundred cubic feet (abbreviated ccf, where the first "c" stands for the Roman numeral one hundred) or thousand cubic feet (abbreviated mcf, where the "m"stands for the Roman numeral one thousand). After the meter has measured the volume of natural gas, the amount of natural gas energy used is calculated by multiplying the volume of the gas by energy units called therms (one therm is equal to 100,000 Btu of energy). This calculation is usually shown on the natural gas bill.

The utility can gather information from meters in a variety of ways. They can have a meter reader go from house to house or building to building to read them. Some utilities have meters that transmit an electronic reading once a month. On others a utility vehicle drives by the home and collects the information without actually coming to the house. To make the job easier, most meters are located on the outside of houses and buildings. Meter reading is usually done about once a month, although other meter reading periods are possible.

Meters can also be used to determine customers' energy use patterns. Daily energy use patterns for residential customers may show that more electricity is used during meal times than at other times. Weekly energy use patterns may show that weekend energy use is higher than weekday use. Utility forecasters and planners use these patterns to make sure that enough energy is available for all their customers at different times of the day and week. Energy use pattern information can also benefit customers by helping them become more aware of how much energy they use and when they use it. This awareness can help customers develop strategies that save money and improve energy efficiency.

Procedure

Orientation

Ask students if they know how the electricity or natural gas used by their family or school is measured. If they do not know, tell students that devices called meters measure the amount of electricity and natural gas people use. Show them the photographs of electric and natural gas meters on ***Meter Locations and Close-Ups***. (Show students actual meters if you have them.)

Ask students where they have seen meters. Responses may include their basement, on the outside wall of a house or building, or on a metal box next to a house or building.

Tell students that they will be reading meters to find out how much electricity or natural gas is used at their homes or school. If a watt meter is available, demonstrate how this gadget measures energy use of various appliances like toasters, lamps, and hair dryers.

Review the definition of kilowatt-hour units with students if electric meters will be read, and cubic feet units if natural gas meters will be read (see **Background**).

Steps

1. Hand out copies of ***How to Read Electric Meters*** and ***How to Read Natural Gas Meters***. Check activity sheet responses for accuracy. As an option, students

can read the meters shown in the photographs or the demonstration meters that have been brought to class.

Go over the different readings the students may encounter. You can learn more about the different numbers your meter will display by contacting your utility provider or visiting their website.

Here are examples of what a meter might display. Help students identify the correct kilowatt hours reading so they can record their observations properly. Once you know which reading it is, it will always appear as the same reading number in the sequence.

000 - Meter Number: the digital number should match the number printed on the meter face.

1 - Date: displayed in six digits.

2 - Military Standard Time: two digit hour followed by period and two digit minutes.

3 - Kilowatt-hours: total kilowatt-hours used in a given billing cycle. Look for kWh after reading.

4 - Kilowatt-hours Peak: number of kilowatt-hours used during peak times in a given billing cycle. Peak time is when the greatest amount of users have a demand for energy. This number is included in reading 3, total kilowatt-hours.

5 - Maximum Demand: the highest amount of kilowatt-hours used in a 15-minute interval during on-peak hours. This is an indicator of the maximum amount of energy needed at any one time in that location. This indicates to the service provider that it must always make at leas this amount of energy available at this location.

6 - Date of On-Peak Maximum Demand: displayed in six digits.

7 - Time of On-Peak Maximum Demand: two digit hour followed by period and two digit minutes.

89 - Program ID: identifies current program running in the meter.

2. Suggest that students ask their parents to help them investigate their home utility meters. For example, during the evening students can use a flashlight to watch the meter for two minutes and then turn off all the lights and other appliances in the house and compare the meter movements. During the day, students can ask their parents to unplug the refrigerator and see how this affects the meter.

   There are sets of sample digital electric meter readings on the KEEP website at keepprogram.org that can be used as examples, for practice calculations, or as a source of data for students who do not have access to an actual meter.

3. Hand out copies of ***Observing Daily Meter Readings***. Have students record the meter data on the activity sheet tables according to the instructions. You may also want to consider the following:
   - If students have both electric and natural gas meters, you may want to divide the class into electric and natural gas meter readers.
   - If students will be reading meters at school, have them share activity sheets and take turns recording meter data on the tables.

Closure

Have students comment on the weekly energy use patterns they graphed, and discuss their answers to the questions on the activity sheet.

Discuss how the readings might vary at different times of the year. Have students make predictions and then plan to conduct the measurements in the future to test their predictions.

Assessment

Formative

- Are students able to properly read the example meters on ***How to Read Natural Gas Meters***?
- How well did students complete ***Observing Daily Meter Readings***? How well did students' observations of home or school energy use correspond to the energy use patterns that they graphed?

Summative

- Ask students if they think the times of the day when electricity and natural gas use at home was highest and lowest were the same for all the students in the class. Tabulate meter reading data from individual students to see when the highest and lowest use of electricity and natural gas occurred. Ask students to explain why the highs and lows may or may not be different.
- Challenge students to design a utility bill that

accurately reports energy use for a month. Evaluate the bills based on student creativity and presentation of information. Show students actual bills and have them compare their creations, noting the strengths and limitations of each.

Extensions

Invite a meter reader or a representative from your local electric or natural gas utility to share further information about meter reading with the class. Find out if they can bring demonstration meters to your class.

Have students record hourly meter readings for one day. See if they can determine which activities use the most energy or if there are certain times of the day when energy is used more.

Considerations for Conducting Activity

Ideally, students can read electric and natural gas meters at their homes and their school ("home" means any type of dwelling—a house, apartment, mobile home, etc.). However, you must consider a number of things before you send students off to read meters. The activity sheets can be adjusted to accommodate these restrictions, if necessary.

- Not every home has natural gas service, and some may not have electric service.
- Electric and natural gas use varies widely for different homes.
- It may not be possible to record changes in meter readings every hour if usage is low.
- Accessing meters in apartments or schools may be difficult or impossible, which means that students will not be able to read them.
- Meters used in apartments may measure the energy used by more than one family or dwelling unit.
- Some meters may not indicate which apartment they correspond to, or may only measure electricity or natural gas used by part of an apartment or a combination of an apartment, an outside hallway, and outdoor lighting.
- The landlord may pay the utility bill and pass along the energy costs to the tenants.
- Students may not be able to read meters outside of normal school hours or on weekends.
- Digital meters may scroll through a series of numbers. These numbers may include date, time, on-peak demand, and other information. For this lesson, students should record the kilowatt-hours for a day to day comparison. Check your local service provider's website or call customer service for an explanation of what student's will expect to see when reading their meter.

Reading Gas Meters Answers

1. 0, 4, 7
2. 6, 0, 8
3. 9, 8, 9
4. 5, 1, 0

Related KEEP Activities

This activity complements "Reading Utility Bills" and "The Cost of Using Energy." Information from this activity supplements "Energy Prices: Laws of Supply and Demand." Students learn how utilities are regulated in the Energy Sparks section Action Ideas: "The Public Service Commission: Regulating Wisconsin's Utilities." Show students Action Ideas: "Energy Efficiency Measures" so they may learn ways to reduce consumption of electricity and natural gas and save money on their utility bills.

The Wisconsin K-12 Energy Education Program is supported through funding from

Wisconsin K-12 Energy Education Program (KEEP)
College of Natural Resources
University of Wisconsin-Stevens Point

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Meter Locations and Close-Ups

Location of an electric meter

Standard Electric Meter

These meters were replaced with digital models throughout Wisconsin in the 2010s.

Digital Electric Meter

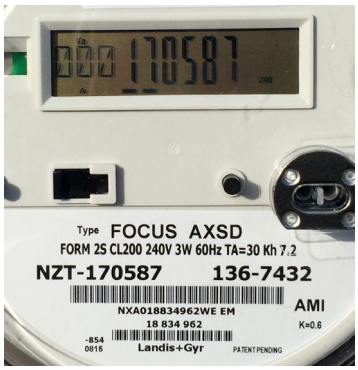
Meter Locations and Close-Ups

Location of a natural gas meter

Natural Gas Meter

How to Read Electric Meters

Electric meters have a digital screen with numbers that look like those on a microwave or DVD player. The display may scroll through a series of different numbers. When you see a row of zeros or eights it indicates the end of one cycle and the beginning of the next. Below are examples of what a digital meter may display.



Here are examples of what a meter might display.

000 - Meter Number: the digital number should match the number printed on the meter face.

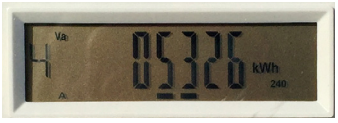
1 - Date: displayed in six digits.

2 - Military Standard Time: two digit hour followed by period and two digit minutes.

3 - Kilowatt-hours: total kilowatt-hours used in a given billing cycle. Look for kWh after reading.

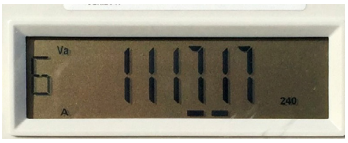
The number you will read and record is kilowatt hours.

4 - Kilowatt-hours Peak: number of kilowatt-hours used during peak times in a given billing cycle. Peak time is when the greatest amount of users have a demand for energy. This number is included in reading 3, total kilowatt-hours.

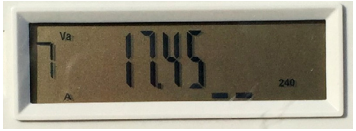


5 - Maximum Demand: the highest amount of kilowatt-hours used in a 15-minute interval during on-peak hours. This is an indicator of the maximum amount of energy needed at any one time in that location. This indicates to the service provider that it must always make at leas this amount of energy available at this location.

6 - Date of On-Peak Maximum Demand: displayed in six digits.



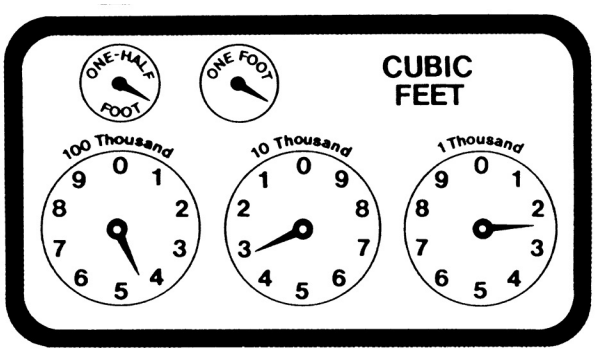
7 - Time of On-Peak Maximum Demand: two digit hour followed by period and two digit minutes.



89 - Program ID: identifies current program running in the meter.

How to Read Natural Gas Meters

To read a natural gas meter, notice the location of the small hand like that on a clock. On the dial on the far right, the numbers go around like they do on a clock. If you look at the dial next to it you will notice the numbers go around in the opposite direction. It reads counterclockwise.



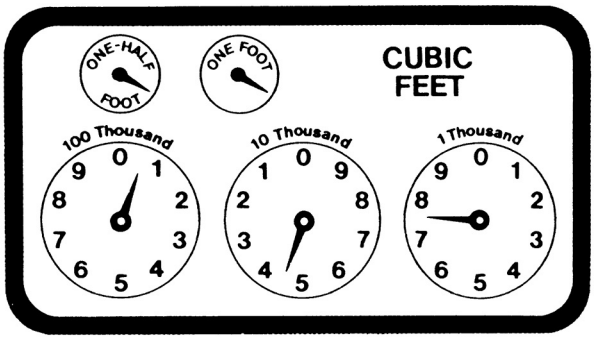
- Usually the hand is between two numbers. The hand is indicating the number which is less, just like a clock.
- If the hand is between two numbers, use the lower of the two numbers.
- The dials read from left to right, just like the numbers on a page.
- If a hand appears to be directly on a number, look at the dial to the right. If the hand on that dial is between 0 and 1, the reading is the number the hand is on. If the hand on the other dial is between 9 and 0, the reading is the next lower number.

Somewhere on the meter are two dials by themselves. They are marked “one-half cubic foot” and “one cubic foot.” The gas company uses these to check the meters to be sure they are accurate. They are not used when reading the meter.

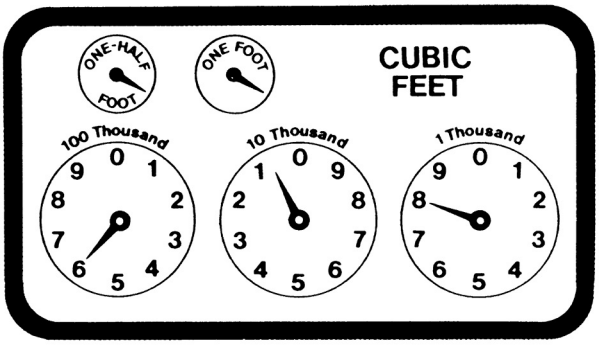
Notice that the dial on the far right is marked “1 Thousand.” That means each time the pointer on this dial goes around, a thousand cubic feet of natural gas has been used. The “5” on this dial therefore means 500 cubic feet. Because there are no hundred’s or ten’s dials, we must add two zeros to our reading to get the correct number of cubic

Write the meter readings below:

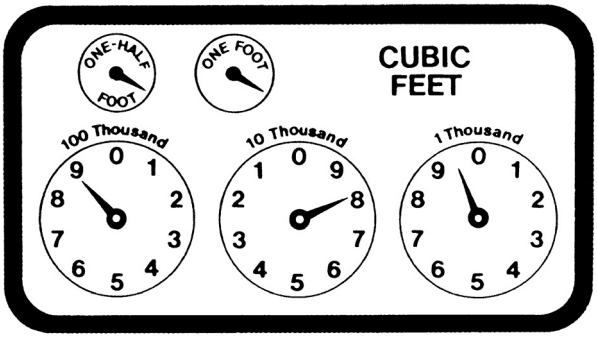
1. _____ _____ , _____



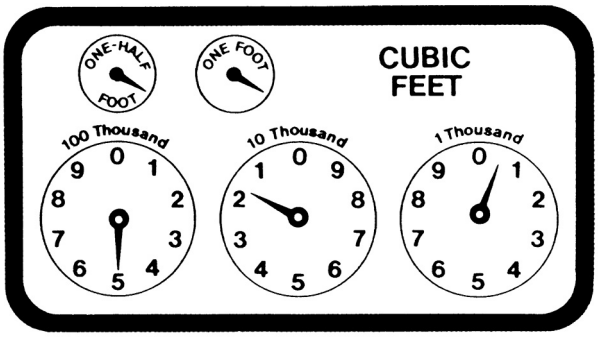
2. _____ _____ , _____



3. _____ _____ , _____



4. _____ _____ , _____



Observing Daily Meter Readings

Introduction

You want to find out how much electricity or natural gas is used each day over the course of a week. To do this, you will read a meter every day, at the same time each day.

Directions

1. Circle the type of meter you are reading. If your home has both an electric and a natural gas meter, make sure your teacher has told you which one you should read.

   Electric (go to Step 2 and then Step 4) **Natural gas** (go to Step 3 and then Step 4)

2. If a multiplier is shown on the electric meter, write it here: _____ Go to Step 4.

3. If you are reading a natural gas meter, write down the cubic-feet units it uses here: _____

4. Fill in the table on the next page with the meter reading data you are recording (see example). Write the units used by the meter in the box labeled "Meter Reading." Try to record your reading at the same time each day. Bring this sheet to class after you have completed the table.

Example:

A student reads an electric meter located on an outside wall of her house. There is no multiplier listed on the meter. Here are her daily meter readings for Monday and Tuesday.

Day of the Week	Time	Meter Reading (List units) kilowatt-hours	Difference in Readings	What was happening and how was energy being used during the day?
Monday	4:30 p.m.	4451		
Tuesday	4:32 p.m.	4457	6 4457 – 4451	Spaghetti dinner (electric stove); family watched TV before bed; breakfast (coffee maker, microwave); then everyone left for school or work.

NOTE: If a multiplier was listed for an electric meter in Step 2, multiply meter readings by the multiplier number before recording them in the table.

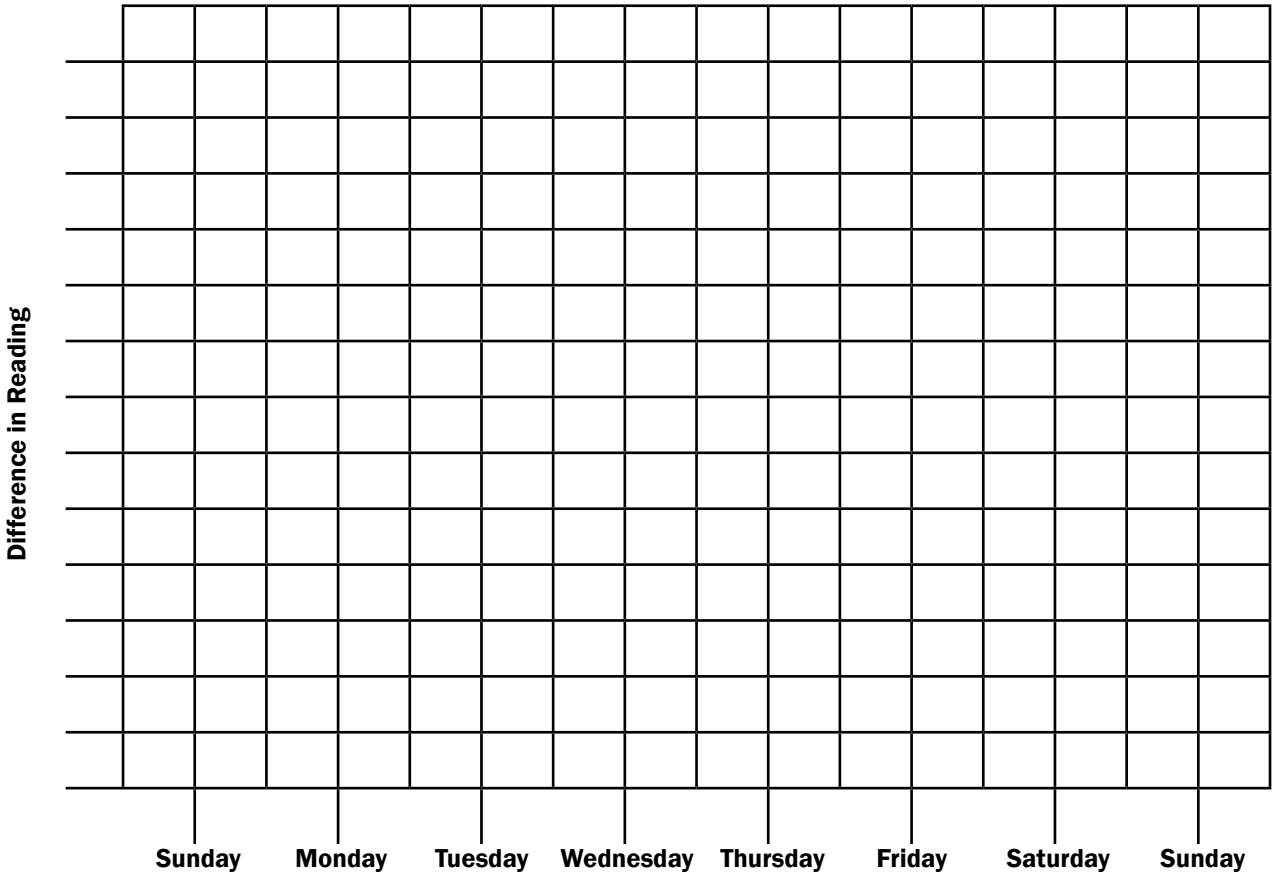
If a multiplier such as "K-10" had been listed on the meter, then the entry for Monday would be 44510 (4451 × 10) and the entry for Tuesday would be 44570 (4457 × 10).

Observing Daily Meter Readings

Day of the Week	Time	Meter Reading (List units) _____ (see previous page)	Difference in Readings	What was happening and how was energy being used during the day?
Sunday				
Monday				
Tuesday				
Wednesday				
Thursday				
Friday				
Saturday				
Sunday				
Total				

Observing Daily Meter Readings

5. On the graph below or on a sheet of graph paper, plot the meter readings for the week.



Questions

1. During which day was electricity or natural gas use the highest? During which 24-hour period was it the lowest?

2. Describe how the use of electricity or natural gas changed during the week. Did it change a lot or only a little?

3. Using your observations of what was happening and how energy was being used from one day to the next, explain the pattern of electricity or natural gas use that is shown on the graph you made.

4. Find out how much your family spent on energy during this time. Multiply the total energy used by the cost per kilowatt/hour (or per therm if measuring natural gas).
Example: If electricity is $0.13/kWh, then 30 kWh x $0.13/ kWh = $3.90

5. Multiply this amount by 52 to get an estimate of your energy costs for a year. What do you think about your family's yearly energy costs?

6. Are there limitations with using this method to estimate your yearly energy costs?
(Hint: Do you think your energy usage will be higher or lower six months from now?)