

Lesson 2: Measuring Electricity

OBJECTIVE

Students will understand common terms used with measuring and using energy efficiently.

KEY CONCEPTS

- Voltage
- Smart Meter
- Watts (W) and Kilowatts (kW)
- On-Peak and Off-Peak Times
- Load Shifting

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LIMITED ENGLISH PROFICIENT, AT GRADE, AND ADVANCED

In this lesson, there are three versions provided for the Tick Tock activity. Each version is designed for a particular ability level. The color-coded outlet in the upper right-hand corner indicates the ability level on the activity:



**LIMITED ENGLISH
PROFICIENT LEVEL**



AT GRADE LEVEL



**ADVANCED
GRADE LEVEL**



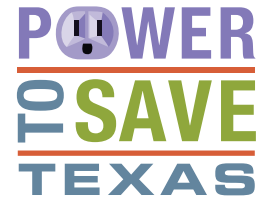
LESSON 2:

Measuring Electricity

Now that you understand a little more about electricity, let's take a look at how it is measured. As you know, electric energy is produced when electrons in an atom are excited due to movement or added heat. When electrons move quickly, they produce a charge. The result is a current we call electricity.

It is easy to overlook all the good things about electricity and its value because we use it all the time. As you're reading this lesson, there may be lights on in the room. The room is conditioned to be cool enough or warm enough to keep you comfortable. Let's take a minute and think of all the ways electricity has helped you in the past 24 hours.

In Lesson 1, we learned how electricity is first generated at the power plant and then moves along



1 Lesson 2: Measuring Electricity

Power to Save Texas School Program © 2014 Public Utility Commission of Texas

LESSON 2 ENRICHMENT

Interactive Links

[Power to Save Texas Enrichment - Peak Tips](#)

This link displays tips for using energy during peak times. The information will help customers save money as well as take steps to be comfortable during specific times of day.

[ENERGY STAR® Kids](#)

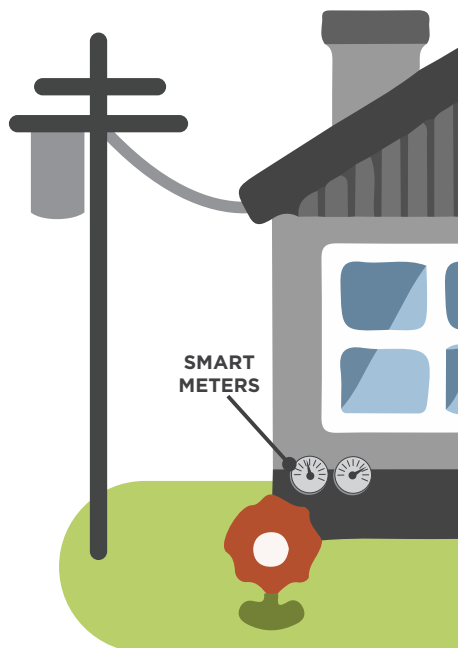
This link helps students learn how easy it is to make everyday changes to help save energy for the future.

[ENERGY STAR®](#)

This link helps students see how changing habits can make a big difference at home when using small electronic devices. Have fun roaming through the ENERGY STAR® house and learn how easy it is to save energy!

the grid. We discussed how substations on the grid act to lower the voltage of electricity. **Voltage** is a measure of electric pressure or electric force.⁸ When this pressure is low enough, the electricity can travel through transmission wires on tall towers. At substations, the voltage is lowered again and the electricity travels through insulated wires to smaller power lines, which can be above or below the ground.

When the electricity reaches homes and buildings, it is through wires that connect to a meter. The meter used for measuring electricity by many homes and businesses today is sometimes called a **smart meter**. The meter measures how much electricity is being used by the electric appliances within the home or business. You might



wonder how electricity is able to be measured correctly. When gasoline is put in cars, the fuel pump shows the price per gallon. When enough gasoline has poured into the car, you can see the total number of gallons you put in, as well as how much it costs. Is the method similar when you use electricity? Thanks to smart meters, the answer is yes.

Smart meters are able to measure the amount of electricity you use, and record the time of day too! You can learn which appliances use more energy, and even see the time of day when your family uses the most energy. The smart meter helps you to actively participate in the process of using energy. It also helps you to take action to save energy. With new technologies like the smart meter, less energy was used in the United States during the past several years.

Smart meters measure electricity in amounts from small to large. Much like there are 16 ounces in a pound, the basic unit for measuring electricity is called a **watt (W)**. You have probably seen some lightbulbs printed with its wattage, stating 100W.

The larger measurements are called **kilowatts (kW)** and are equal to **1,000 watts**. When the electrical bill comes to your home, it usually shows electricity measured in **kilowatt hours (kWh)**.⁹ This is just an easy way to say that 1,000 watts of electricity were used for one hour. The chart on the next page shows common household devices and watts consumed.¹⁰



Table 1

DEVICE	WATTS CONSUMED
Alarm clock	5-100
Ceiling fan	65-175
Cell phone charger	4
Clock radio	10
Clothes dryer	1,800-5,000
Clothes washer	350-500
Color television (36")	133
Dishwasher	1,200-2,400
DVD player	23
Game console	195
Hair dryer	1,200-1,875
Heater (portable)	750-1,500
Microwave oven	750-1,100
Printer	25-35
Refrigerator (16 cu. ft)	725
Toaster	1,225
Water heater (40 gallon)	4,500-5,500

Andy Average works in the city and enjoys going for hikes on weekends. When he is home, he doesn't like to pay too much attention to his bill, but does



turn off the lights most of the time when leaving a room. Even so, he is known to fall asleep with the television on, and sometimes it's on all night long. Andy turns up the heat on cold winter days, but once in a while tries to wear an extra sweater instead of really cranking up the thermostat. In the summer, when it gets really hot, Andy will try to help keep the house cool by closing the blinds. Andy has replaced a couple of light bulbs with CFLs (compact fluorescent lamps), but hasn't made many other changes to help lower his utility bill. He knows he should only run the dishwasher and washing machine when there's a full load, but sometimes it's just easier to run these machines when he's in the mood. He knows he can check his smart meter online, and will try to do it one day soon.

CALCULATING KW CONSUMPTION

$$\frac{\text{watts or demand}}{\text{watts or demand}} \times \frac{\text{actual \# of hours used}}{\text{actual \# of hours used}} = \frac{\text{watt-hrs used in a day}}{\text{watt-hrs used in a day}}$$

$$\frac{\text{watt-hrs used in a day}}{\text{watt-hrs used in a day}} \div \frac{1,000 \text{ kilowatt}}{1,000 \text{ kilowatt}} = \frac{\text{kWh used in a day}}{\text{kWh used in a day}}$$

$$\frac{\text{kWh used in a day}}{\text{kWh used in a day}} \times \frac{\text{cost of a kWh}}{\text{cost of a kWh}} = \frac{\text{cost of use in a day}}{\text{cost of use in a day}}$$

$$\frac{\text{cost of use in a day}}{\text{cost of use in a day}} \times \frac{\text{days used per year}}{\text{days used per year}} = \frac{\text{annual cost of use}}{\text{annual cost of use}}$$

Shane Smart

works in the city and makes sure that everything is turned off before he leaves for work. He pays close attention to his bill, turns off lights every time he leaves a room, and unplugs appliances when he's not using them. On cold winter days, Shane keeps the heat at a reasonable temperature, wears extra clothing to keep warm, and keeps a blanket on the couch in case he gets cold. In the summer, Shane keeps the house cool by closing the blinds and leaving the doors and windows closed. Shane takes advantage of the warm weather by hanging his clothes outside on the clothesline to dry; the clothes always smell fresh this way. When Shane has to use his clothes dryer, he makes sure that it is during off-peak hours. Shane has replaced all light bulbs with CFLs. He only turns on the dishwasher when it's full, and does the same when washing a load of clothes, while also checking to make sure it's around 8:00 PM. Shane keeps an eye out for new ways to save on his utility bill by following his smart meter online.



winter days, Whitney cranks up the heat until she's comfortable and wears extra sweaters only when she goes outside. In the summer, Whitney keeps the house cool by running the air conditioning all day long. If Whitney comes home for lunch, she'll open the side door to enjoy the warm summer air and may forget to close it again when she leaves. Whitney has heard of CFLs and is considering buying one someday. She turns on the dishwasher a couple of times a week when she runs out of spoons, and uses her washer and dryer whenever she needs blue socks. Whitney complains about her utility bill and thinks a smart meter is used for the parking spaces downtown.



Whitney Wasteful works close to home and doesn't worry about her utility bill at all. Her bill is higher than most, but, oh well. Whitney leaves lights on every time she leaves a room and never unplugs any of her appliances. On cold

Now that you understand a little more about the special way electricity is measured, we can look at some other things unique to electricity. The utility company needs to have electricity ready when people need it. If people don't use all the electricity provided, the utility company cannot send it back through the power poles to the place where it was generated. If there is a sudden increase in the need for electricity, the utility company can't quickly install more power poles and string up new transmission lines.

Green Link

Click on the green word “energy” in the student lesson to find “energy hogs” at the Hogbusters Training Camp.

Utility companies have to keep a balance between the amount of electricity they generate and the amount people need. You might think of it like this: if you were going to have a couple of friends come over this weekend, you would probably make sure there were enough snacks in case someone got hungry. But, what would you do if each of your friends brought their entire family with them? Would you still have enough snacks for everyone? It's the same with electricity.

At certain times of the day, people use more electricity. You would probably guess that there is not a high demand for electricity at three o'clock in the morning, and you would be right. When most families come home from school or work, you would think people use more electricity, and you would be right again. It makes sense that the utility company tries to balance the need for electricity so everyone can enjoy it.

The times during the day when everyone wants to use electricity is called **On-Peak**. During this time the utility company is producing and delivering more electricity and the risk for the electrical grid getting out of balance is high. **Off-Peak** time is the time of day when there is less demand for electricity. To help prevent a shortage in

electricity during on-peak time, the utility company asks that we practice **load shifting**.¹¹

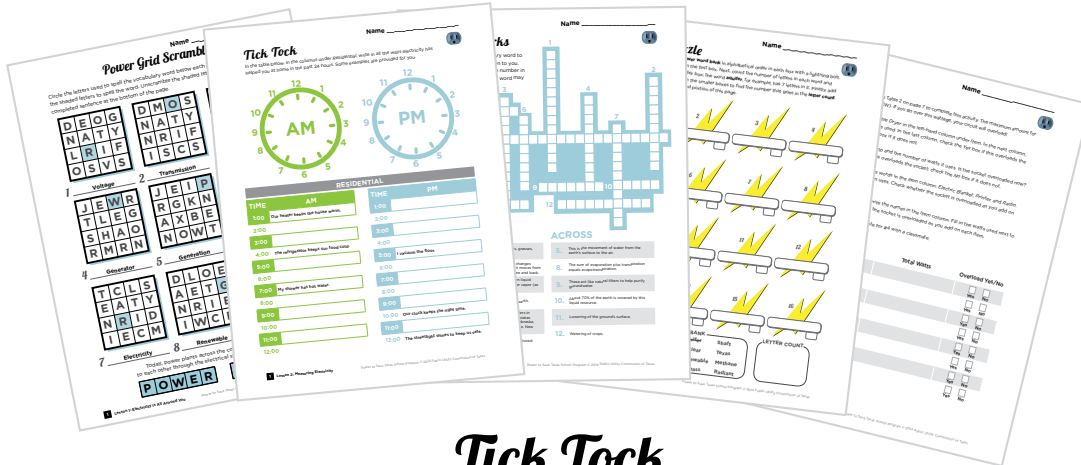
Basically, it is suggested that we not run the dishwasher or a load of laundry during on-peak times. It makes sense to shift activities, and you probably do this in your life anyway. If you try to avoid being the last one in the lunch line when there is a big crowd of people in front of you, you have made a shift in your routine to help things go smoothly. The same is true with electricity.



You can be smart about how you use electricity. You understand how power plants generate electricity, and you know about the concept of on-peak time. You might be surprised to learn that only 80% of the people in the world have access to electricity, yet the average American household uses 4,500 kWh per year in their home - that's six times more than the global average!¹²

In the next lesson, you will learn about new ways to save energy, and where energy is wasted in your home without you even knowing it. You will be prepared with the knowledge to make a difference in the way you and your family use [energy](#).

NOTES:







Tick Tock

Ask your teacher for the Tick Tock activity. You will receive one of three versions. Tick Tock asks you to think of all the ways electricity helps you in your daily life. This activity uses clocks for both morning and evening to identify how electricity works or can be saved.

Long-Term Savings for Homes Tips

AC & HEAT

-  Do not use humidifiers or swamp coolers with the AC.
-  If your AC or heater is more than 15 years old, consider replacing it with a more efficient model.
 - Newer models use up to 40% less energy.
-  Consider installing a whole-house fan for better circulation.
-  Maintain your AC and heater so they work efficiently.
 - Check your air and/or furnace filters every month when in use. Replace them at least every three months.
 - If you can, have your HVAC unit inspected and maintained by a licensed professional in the spring and/or fall.

See more at www.powertosavetexas.org.

Scan this QR Code with your smartphone to visit the program website.



Power to Save



Andy Average



Shane Smart



Whitney Wasteful

My Average Monthly kWh usage:	2750 KWH	1000 KWH	4500 KWH
Cost I pay per kWh:	\$0.11/KWH	\$0.06/KWH	\$0.18/KWH
In the summer I will raise my thermostat by:	3°	1°	5°
In the winter I will lower my thermostat by:	3°	5°	1°
I will lower my water heater temperature by:	10°	10°	10°
Number of 100 watt incandescent bulbs I will replace with CFLs:	2 bulbs	10 bulbs	1 bulb
Number of hours I currently leave my incandescent bulb on per day:	5 hours	3 hours	10 hours
I will hang dry my laundry:	No	Yes	No
I will use a power strip to turn off 6 electronic devices when not in use:	Yes	Yes	No

Go to www.powertosavetexas.org/Home/SavingsCalculator to fill in their potential savings.

Andy Average

Monthly Summer

\$74.22

Monthly Winter

\$34.89

Annually

\$654.64

Shane Smart

Monthly Summer

\$21.21

Monthly Winter

\$22.41

Annually

\$261.77

Whitney Wasteful

Monthly Summer

\$254.64

Monthly Winter

\$59.34

Annually

\$1,829.93

Focus on 5

Use these five questions for reflective journaling, short paragraph essays, or class discussion:

Reflective Journaling

1. List at least three positive attributes about this career that you found interesting or appealing.
2. List at least three negative attributes about this career that you thought did not apply or appeal to you.

Short Essays

3. Why do you think the future of this job is predicted as it is shown?
4. In your city, who would be an employer you could contact to ask for more information about this career choice?

Class Discussion

5. Why do you think this job was featured as a part of this lesson?

Career Connection / Job Profile:



Do you like to draw?

Do you like to figure out how things are put together?

Are you good at math?

If you answered, "Yes," to these questions, you might like to be a draftsman. Draftsmen change the designs that engineers and architects make into technical drawings and plans. Workers use these plans to build everything from computer chips to skyscrapers. Draftsmen use computer-aided drafting (CAD) equipment to do most of their drawings. They do some work by hand with drafting tools.

As a draftsman, you would:

- Visit job sites and talk with clients to learn about designs.
- Study work orders, drawings, and maps and measure sites.
- Check building codes and laws to see how they will affect designs.
- Decide what types of drawings to do and how to order the work tasks.
- Figure what materials will be needed and how much they will cost.
- Use CAD equipment or drafting tools to make drawings and plans.
- Review finished plans to make sure they are right and make copies.
- Write instructions to go with plans and explain them to workers.
- Help workers and staff solve problems and change designs if needed.
- Direct and train drafters and other staff.

Will There Be Jobs in the Future?

In Texas, this occupation has high growth potential. Nationally, this occupation is growing at an average rate.

Education Required:

To work as a draftsman, you typically need to:

- Have a high school diploma or GED; and
- Have an associate degree.

Provided courtesy of: www.onetonline.org

NOTES:

Focus on 5

Use these five questions for reflective journaling, short paragraph essays, or class discussion:

Reflective Journaling

1. List at least three positive attributes about this career that you found interesting or appealing.
2. List at least three negative attributes about this career that you thought did not apply or appeal to you.

Short Essays

3. Why do you think the future of this job is predicted as it is shown?
4. In your city, who would be an employer you could contact to ask for more information about this career choice?

Class Discussion

5. Why do you think this job was featured as a part of this lesson?

Career Connection / Job Profile:

Are you good at selling things?
Do you like working with other people?
Do you like to plan and organize activities?



If you answered, "Yes," to these questions, you might like to be a marketing specialist. Marketing specialists are among the top managers in companies. They are in charge of how companies sell their products or services. First, they figure out which groups of people might buy certain products. Then, they work with other departments to advertise and sell products to those people.

As a marketing specialist, you would:

- Talk to experts and do surveys to see what products people might buy.
- Do research on business trends to see if new products are worth making.
- Discuss designs with staff and track costs as products are made.
- Make lists of products and figure out how much to charge for them.
- Create plans for how to sell a company's products.
- Work with other managers to create ads and go to trade shows.
- Write contracts with those who will distribute the products.
- Hire, train, and be in charge of the marketing and sales staff.
- Study green ideas and plan to make products that protect resources.
- Make green information part of product sales plans.

Will There Be Jobs in the Future?

In Texas and nationally, this occupation is growing at an average rate.

Education Required:

To work as a marketing specialists, you typically need to:

- Have a high school diploma or GED; and
- Have a bachelor's degree.

Provided courtesy of: www.onetonline.org

NOTES:

Stop Directions - Page 2

Objective:

Students will be exposed to the concept of measuring the cost of electricity.

Instructions:

Use Table 1 and “Calculating kW Consumption” on page 3 to measure the cost of electricity. Select a device from Figure 1. Take note of the watts consumed (demand). The watts (W) consumed amount is placed on the first line in “Calculating kW Consumption.” The actual number of hours used is written on the line immediately to the right. Together the watts (W) and the number of hours used are multiplied to learn the watt-hours used in one day. Divide this answer by 1,000 to arrive at the number of kilowatt hours (kWh) used in one day.

In the next equation, ask students to use their answer for the kilowatt hours (kWh) used in one day and multiply it by the cost of one kilowatt hour (kWh) obtained from a power bill (or the amount \$0.10 may be used). Together, the kilowatt hour (kWh) used in one day is multiplied by the cost per kilowatt to learn the cost of use for one day. To learn the cost for one year, multiply the cost of use in one day by the days used per year (365).

Small group formations are recommended if your class has a combination of all three learning abilities. In this way, the students may work together on the task. The following example may be displayed for students in order to explain the mathematical process:

1. A portable 1,500 watt heater used for one hour equals 1,500 watt-hours (Wh). [$1,500 \text{ W} \times 1 \text{ h} = 1,500 \text{ Wh}$] This amount of energy is consumed by this appliance.
2. The watt-hours (1,500 Wh) divided by 1,000 watts would equal the kilowatt hours (kWh) used in one day. [$1,500 \text{ Wh} \div 1,000 \text{ W} = 1.5 \text{ kWh}$]
3. The kilowatt hours (kWh) used in one day, multiplied by the cost of one kilowatt hour (kWh), equals the cost of using the electricity for one day. The smart, or electric, meter on your house records the kilowatt hours (kWh) used in your home.
4. The cost of using the appliance for one day, multiplied by the numbers of days used per year, equals the annual cost of using the appliance.

Stop Directions - Page 4

Objective:

Students will be exposed to both the concept of measuring the cost of electricity as well as how their behaviors affect the utility bill.

Instructions:

Using the [Savings Calculator](http://www.powertosavetexas.org) at www.powertosavetexas.org, have students complete inputs for the habits of Andy Average, Shane Smart, and Whitney Wasteful, and then fill in their summer, winter, and annual potential savings. All necessary information is provided below the three characters in the Power to Save activity on page 7 of Lesson 2. Students will move down vertically to input the data and see how their estimated potential savings can change. Their results will change in the top right green box on the screen and are to be entered in the boxes provided on page 7. Students who find this difficult may be placed in groups of two in order to complete the exercise together.

Learn and Know

Discuss the contrasting habits of Andy Average, Shane Smart, and Whitney Wasteful with regard to energy usage. Once the discussion is finished, ask students to reflect on the information presented thus far with the questions below. The reflection may take place in written or group discussion format.

Q: With which character do you most closely relate?

Q: Do you know anyone whose personality resembles that of one of these characters?

Q: What changes would you recommend for these characters?

Stop Directions - Page 6

Visit the [Teacher Portal](#) to access all three versions of the Tick Tock activity to distribute to your students. Directions for this activity are listed below.

Objective:

Students will be exposed to the concept of measuring the cost of electricity.

Instructions:

Distribute Tick Tock, a reflective activity. Ask students to fill in all blanks for both day and night activities. Students may need to be reminded that the electricity is on even while they are asleep. Students may share their lists with a partner, a group of students, or with entire class.



Limited English Proficient

In the table below, in the columns under *Residential*, write in all the ways electricity has helped you at home in the past 24 hours. Some examples are provided for you.



At Grade Level

In the table below, in the columns under *Residential*, write in all the ways electricity has helped you at home in the past 24 hours. An example is provided for you.



Advanced Grade Level

In the table below, in the columns under *Residential*, write in all the ways electricity has helped you at home in the past 24 hours. Next, in the columns under *Commercial*, write in all the ways electricity has helped your community (in its buildings or within your city) in the past 24 hours.

Additional Instructions:

Once students have completed reading all of page 5, which addresses On-Peak and Off-Peak Times, students will return to the Tick Tock activity page and indicate which of their activities they should consider conducting at alternate times. Pairing and sharing may take place once students have marked the activities targeted for a different time of day.