

ENERGY-WATER NEXUS STEM INVESTIGATIONS

Energy Conservation Challenge (SDG 7)

KEY LEARNING OBJECTIVES

Students will be able to

- **Measure** power used by appliances.
- **Estimate** the time each appliance is used daily.
- **Calculate** the amount of money required to use the appliance each year.
- **Develop** a plan to reduce energy consumption.

OVERVIEW

Students will use a Watt meter to test and estimate the power and energy consumed by several household appliances. Students will work in small groups, rotating among stations, to test each appliance. They will:

- Record the power or current specified for each appliance
- Measure the power using a Watt meter, explore the potential impact of various settings on the power consumption (low vs. high setting)
- Measure the power drawn when the appliances are off
- Estimate the time they would use each appliance daily
- Calculate the energy consumed daily for each appliance

Students will use the data to calculate how much money they spend daily when using these appliances. Using this information, students will develop a plan to reduce their energy consumption.

CONNECTION TO THE ENERGY-WATER NEXUS

- Electrical power generation is one of the biggest consumers of water.
- Water scarcity, variability, and uncertainty are becoming more prominent, potentially leading to vulnerabilities of the U.S. energy system.

NATIONAL STANDARDS

Next Generation Science Standards

- **MS-ESS3-3 Earth and Human Impact**
Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

- **4-PS3-3 Energy**

Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electrical currents.

BACKGROUND

According to the U.S. Energy Information Administration, in 2019, the average monthly electricity bill was \$115. Determining how much electricity your appliances and electronics use can help you understand how much money you spend to use them. The electronics and appliances we use require varying amounts of power. Power is the amount of energy transferred or converted per unit of time and is measured in Watts. Watt meters provide a convenient way to measure power consumption. Appliance labels also contain information on power consumption. You can calculate the total electrical energy used by measuring the power use of the appliance and the time it is used.

KEY VOCABULARY

- Power
- Volt
- Electromagnetic energy
- Current
- Watt
- Amps

MATERIALS

- Electrical appliances (one per group)—hair dryer, lights (LED, holiday, lamp with various settings), blender, slow cooker, fan, electric drill, computer, phone charger
- Watt meter—one per group
- Extension cords, power strips

TEACHER PREPARATION

- Place appliances and Watt meters in stations around the room using extension cords and power strips as needed.

PROCEDURE

1. To begin the lesson, ask students what water and electricity have in common. Lead a short discussion on how water and energy systems depend on one another. Energy is required to treat and distribute water for human use. Explain that water is used in all phases of energy production and electricity generation. More than half of the electricity generated in the United States comes from power generators that need cooling. In thermoelectric plants, water is boiled to produce steam for generating electricity. Hydroelectric power plants use dams and other methods to capture the energy moving in water.
2. Share with students that the United Nations adopted sustainable development goals. Use the [link](#) to scroll through the website to introduce the goals. Explain that the sustainable development goals were

developed to achieve a better and more sustainable future for all. They address the global challenges we face, including poverty, inequality, climate change, environmental degradation, peace, and justice. Today we are going to focus on goal 7, to ensure affordable and clean energy.

3. Explain to students that they will be working in small groups of four. They will use a Watt meter to test and estimate the power and energy consumed by several household appliances. Explain that to reduce energy consumption, the first step is to evaluate how much energy we consume. Understanding the problem and gathering information are two essential steps in the engineering design process.
4. Introduce the stations set up around the room and demonstrate how to use the Watt meter.
5. Explain that each group will record the name of the appliance and the Watt reading used in the data table. If the appliance has various settings, record the power for those on separate rows. Most appliances use a small amount of standby power when they are switched off. Remind groups to measure the power draw when the appliances are off as well. They should estimate the daily use (if applicable) and record that time in the data table. They will complete these steps for each station visited.
6. To close the activity, when groups are finished gathering data from each station, have them work collaboratively to answer the analysis questions on their handout.
 - Review the list of appliances you use regularly and calculate the daily energy consumption using the formula below. Record your daily energy consumption in the data table.
 $(Wattage \times Hours \text{ Used Per Day}) \div 1000 = \text{Daily Kilowatt-hour (kWh) consumption}$
 - Calculate the annual energy consumption for those appliances using the formula below.
 $\text{Daily kWh consumption} \times \text{number of days used per year} = \text{annual energy consumption}$
 - Calculate the annual cost for those appliances using the formula below. The utility rate is 13 cents per kWh.
 $\text{Annual energy consumption} \times \text{utility rate per kWh} = \text{annual cost to run appliance}$
 - Did any of the appliances have a known power rating? How did your measured value compare to the specified amount?
 - Develop a plan to reduce your energy consumption. Are there settings you can use more frequently that use less electricity? What are the ages of your appliances at home? Are they ENERGY STAR rated? Conduct some research and identify 2–3 smart devices that would improve your home's energy efficiency.

EXTENSION

Have students conduct research and create a flowchart on where their electricity comes from and how it reaches their home.

Students could also explain how their family's energy needs have an impact on climate change.

Sources

https://www.eia.gov/electricity/sales_revenue_price/pdf/table5_a.pdf

<https://www.youtube.com/watch?v=5RidqDiljho>

<https://www.un.org/sustainabledevelopment/sustainable-development-goals/>

Analysis

- Review the list of appliances you use regularly and calculate the daily energy consumption using the formula below. Record your daily energy consumption in the data table.
(Wattage × Hours Used Per Day) ÷ 1000 = Daily Kilowatt-hour (kWh) consumption

- Calculate the annual energy consumption for those appliances using the formula below.
Daily kWh consumption × number of days used per year = annual energy consumption

- Calculate the annual cost for those appliances using the formula below. The utility rate is 13 cents per kWh.
Annual energy consumption × utility rate per kWh = annual cost to run appliance

- Did any of the appliances have a known power rating? How did your measured value compare to the specified amount?

- Develop a plan to reduce your energy consumption. Are there settings you can use more frequently that use less electricity? What are the ages of your appliances at home? Are they Energy Star rated? Conduct some research and identify two or three smart devices that would improve your home's energy efficiency.