

Home Energy Audit

Last Updated: July 25th, 2013

Background

While energy and power are often confused and treated as synonyms, they have precise definitions that differ from one another. Energy is the capacity of a system to perform work (Zimmerman Jones, Andrew). It is used as a term to measure how much of something, or to describe an amount. For example, a particular amount of **energy** is required to perform a task such as moving your arm up and down. On the other hand, power describes how much can be produced, and is how we describe the size of something that produces energy. In the arm lifting example, the power required for that action will be measured in terms of **energy per second**. (Solar Choice).

A homeowner can use a power meter to measure the electric power used by appliances in their household (WordNet Search), thus performing part of a home energy audit. By finding out where the most electricity is used, a home energy audit can help highlight how electricity use can be reduced in a house, thus decreasing both a homeowner's electrical bill and carbon footprint. A professional energy auditor would examine the entire structure of the house, study past electric bills, and measure how airtight the house is to determine if energy is being wasted heating or cooling the air (Department of Energy).

If a power meter is being used to perform a more basic home energy audit, a quick calculation can be done to find annual electricity consumption. First, use the power meter to find the amount of electricity (*power*) used for an appliance in terms of **Watts**. Then, determine about how many hours that appliance is used per day (*time*). Finally, calculate the energy using this equation.

$$Energy = Power * Time$$

Note, while watt-hour per day is a possible metric, typically a homeowner's energy bill measures energy in **kilowatt-hour (kWh)** per month or per year (Personal Electricity Consumption Assessment).

Objectives

Students will be able to:

- Describe the difference between power and energy by giving examples of high-power and high-energy devices.
- Compare the electrical demand from various in-home devices and calculate the cost—in terms of monthly electricity bills—of each.

Materials

- Various electrical devices marked with an index card. Potential devices include: lamps with different light bulbs, gaming systems (Nintendo etc.), toaster, iron, cell phone charger, i-pod charger, laptop computer, external monitor, cable modem, wifi router, fan, space heater, power drill etc.
- Power meters
- Presentation: “Measuring Your Electricity Consumption.pptx”
- Worksheet: “Personal Electricity Consumption Worksheet.pdf” (note there is an extra white page provided in the handout since students will likely need some scratch space)
- Workbook: “Chart of students electricity consumption.xlsx”
- Computer with Microsoft Excel or program able to load Excel
- Projector
- Calculators (ask students to bring?)

Safety Concerns



- None.

Vocabulary

- Energy: the capacity of something to do work; an amount. Measured in watt-hours, kilowatt-hours, megawatt-hours.
- Power: describes how much energy can be produced in a given time. Also to supply a device with electricity; the product of voltage and current. A common unit of measurement is a *watt* (W); also measured in watts, kilowatts, megawatts, etc.

Experiment

Time	Activity	Description	Supplies
5	1. Introduction to electrical sources in the home	<ol style="list-style-type: none"> 1. Have students think about their homes and name everything they can think of that uses electricity. 2. For each of the sources mentioned by the student, categorize them as “minor”, “medium”, or “major” uses of electricity. <ol style="list-style-type: none"> a. E.g., I expect my Nintendo to be a minor user of electricity, while my refrigerator is a major user of electricity. b. Think about this in two ways—I’ve got an electric chainsaw at home, which uses a ton of electricity, but I only use it once or twice a year. On the other hand, I’ve got a cell phone, which uses only a tiny amount of electricity, but I charge it every night. I’m interested in total electrical usage, so at the end of the year, my chain saw is probably minor. 	Computer, projector, presentation

		My cell phone may be medium.	
5	2. Demonstrate Power Meters	<ol style="list-style-type: none"> Choose a pair of students to demonstrate the use of power meters. <ol style="list-style-type: none"> Have the pair of students measure the power consumption of a sawzall or a power drill. Have a separate pair of students measure the power consumption of charging a cell phone. 	Worksheet, power meters
15	3. Measuring Activity	<ol style="list-style-type: none"> Have the students divide into groups of two. Give the students 15 minutes to measure the electrical consumption of as many devices as they can.  	Worksheet, power meters
10	4. Calculating Energy Cost Example	<ol style="list-style-type: none"> Bring the students back together and pick a few devices they measured. For those devices, as a class, calculate the annual energy usage and give the cost. 	Worksheet, calculator
10	5. Calculating Energy Cost	<ol style="list-style-type: none"> Have the students get back into their groups of two from before. Give them 10 minutes to calculate annual energy consumption for all the devices they measured. 	Worksheet, calculator
5	6. Report findings	<ol style="list-style-type: none"> Have the students report their findings. Ask them questions such as: <ol style="list-style-type: none"> Did any devices have surprisingly high energy or high power usages? Did any devices have surprisingly low energy or 	

		lower power usage?	
15-20	7. Questions in Pairs	<ol style="list-style-type: none"> Assign each pair one of the following questions to investigate: <ol style="list-style-type: none"> Is the little stuff a bigger deal than the big stuff? Annually, do you spend more money on electricity or gasoline? Classify devices based on high / lower power and high / low energy. Are there any surprises? What are possible sources of “parasitic losses”? Are these a big deal? Groups may need some individualized attention to get started. If one group finishes their question early, they can move onto the next one. 	Power meter, calculator
10	8. Group Discussion	<ol style="list-style-type: none"> Have students report their findings. Close by having students explain the difference between energy and power. 	
15	9. Optional activity	<p>Optional (integrate at appropriate points above):</p> <ol style="list-style-type: none"> If time, ask students to list the power (watts) for each item measured on the board (or on the overhead). Come to an agreement on the power measured for each. Ask students to estimate their personal use of all of these devices each year. Have students calculate the energy they estimate they will use by these devices and report back to the lecturer While students are completing “#7 Questions in pairs”, lecturer inputs students names and reported annual electricity consumption into the workbook. Display chart, discuss Compare to final charts in presentation. 	Worksheet, workbook, presentation, calculator, computer, projector,

Additional Resources

Reputable

Department of Energy. “Home Energy Audits: Making Homes More Energy Efficient

and Comfortable.” Department of Energy. 21 Mar 2013. Web. 25 Jul 2013. <<http://energy.gov/articles/home-energy-audits-making-homes-more-energy-efficient-and-comfortable>>

The Department of Energy page on home energy audits describes, in detail, the process of completing a professional energy audit and the benefits of having completed one.

Solar Choice. “Physics 101 – what is the difference between power and energy?” Solar

Choice. Web. 25 Jul 2013. < <http://www.solarchoice.net.au/blog/power-and-energy/>>

Solar Choice describes the difference between energy and power in simple, comprehensible terms.

Opinion / Newspapers

“Personal Electricity Consumption Assessment.” PDF File. 25 Jul 2013.

The PDF file illustrates how to calculate energy consumption per year, and gives students the space to do their own calculations below the example.

WordNet Search. “WordNet Search – 3.1.” Web. 25 Jul 2013.

<<http://wordnetweb.princeton.edu/perl/webwn?s=power%20meter>>

The WordNet Search page defines what a power meter is.

Zimmerman Jones, Andrew. “Energy – definition of energy.” About.com Physics. Web.

25 Jul 2013. < <http://physics.about.com/od/glossary/g/energy.htm>>

The About.com page on energy gives the definition of energy used in physics and briefly describes the law of conservation of energy.

Author(s)

Lesson idea from Kyle Silar-Evans; final product compiled by Sabrina Larkin on behalf of the Leonard Gelfand Center for Service Learning and Outreach.

Funding Sources

Portions of this work were supported by a) the Leonard Gelfand Center for Service Learning and Outreach, and b) the Center for Climate and Energy Decision Making (SES-0949710) through a cooperative agreement between the National Science Foundation and Carnegie Mellon University.

Next Generation Science Standards Alignment

PS3.A: Definitions of Energy

PS3.C: Relationship Between Energy and Forces