

# **Energy Audit and Efficiency Project**

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### Lesson Overview

The purpose of this lesson is to develop student understanding of the economic and environmental impact of energy use and energy management in a society where energy costs are rising as fossil fuels become increasingly scarce. Through personal investigation, students will learn how they can become more energy savvy.

#### Materials Included in this Lesson

- Standard Appliance Energy
- Consumption Chart Energy
- Efficient Appliance Consumption
- Chart Energy Audit Worksheet

#### Other Materials for this Lesson

- Calculating Energy Saving Worksheet
- Individual Grade

#### After completing this lesson, students will be able to:

- Understand that collectively, our daily routines can have a significant environmental and economic impact.
- Identify several ways to reduce energy consumption in the home.
- Analyze a set of data for possible energy wasting activities and use that information to design a solution that results in higher energy efficiency.
- Present their solution to a problem in an organized and efficient manner.

#### Student Deliverables

- Complete energy audit worksheet
- Present how much money is saved and how energy efficient appliances are better for the environment.
- Create a system of linear equations that compared standard vs. an energy efficient appliance and its cost over the years.

Length of Lesson: 3 Days

#### Activity Day One

##### *Introduction (15 min.)*

Discuss electricity consumption in the United States in comparison to other parts of the world. Give statistics if possible. Explain the environmental and economic impacts of high levels of electricity consumption and what renewable sources of energy are. Talk about different types of power sources such as wind, fossil fuel, hydro, nuclear power and solar energy

### Preparatory Activities & Prerequisite Knowledge:

Basic algebra skills are required to perform some calculations, though simple addition composes the majority of the exercises.

Vocabulary:

Energy	Kilowatt hour	Efficiency	Wattage
Energy end user	Energy provider	Voltage	Amperage

Students should have completed a unit on energy and energy sources in which they have gained a general understanding of where electricity comes from and how electricity helps us to do work.

Student understanding of renewable energy technologies is suggested and students should be already familiar with:

Electricity	Fossil Fuels	Renewable Energy
Electric Current	Wattage	General Algebraic
Hydro/Nuclear Power		

### Activity Day Two

#### *Introduce Energy Audit Assignment (15 min.)*

Discuss the capability to reduce energy consumption through energy efficient technologies and practices.

Review **Standard Appliance Energy Consumption** (Data Sheet 1) and **Energy Efficient Appliance** (data sheet 2) data sheets for use in energy audit

Explain to students that the techniques and data used in this exercise are simplified for student use. Professional energy audits are very precise and more complex.

Explain rules for calculating energy usage in the school. Discuss proper behavior while auditing the school. (Other teachers may not appreciate loud students in the hallways)

#### *Guided Energy Audit of the School (30 min.)*

Accompany students throughout the school as they record type and number of light-fixtures and appliances. Refer to the **Standard Appliance Energy Consumption** data sheet for appliances that can be used in this exercise.

Draw attention to the appliance information tags that can be found either on the back or bottom of most appliances. These tags generally contain voltage and amperage as well as additional information supplied by the manufacturer.

Use any available opportunity to point out energy efficient or wasteful practices.

### *Compile Energy Audit of the School (20 min.)*

Instruct and lead students in calculating energy consumption and energy savings for the school using data sheet 2.

Discuss results.

### Activity Day Three

#### *Introduce Home Energy Classwork (40 min.)*

Explain that the same principles apply to the home energy audit as the school energy audit, but likely more energy efficient technologies are available for home appliances than in the school.

Give students worksheets for home energy audit and assign the audit as homework. They can choose 5-10 appliances from the standard appliances and energy star appliances and **calculate how many watts was saved** and the **how much money is saved** each month and yearly.

Review **Calculating Energy Savings ( Use Data set 2A)** worksheet. Remind students to take note of the appliance information tags that are easily accessible to them as they perform their energy audit. Create a system of linear equations for regular and energy efficient fluorescent light bulbs, include a t-chart and graph the system on a rule of four poster.

NOTE: Be sure to remind students to be extremely careful when handling electrical appliances. Disconnect appliances from power source if possible. Suggest that students try to discover ways to conserve electricity at home. Familiarize students with the grading rubric.

### Enrichment Suggestions

After doing the in class energy efficiency worksheet, students can do an energy audit of their own home to see how much power they are conserving or not. They can also present what ways they can conserve energy and how much money they are spending on non energy efficient bulbs or appliances.

### Student Resources

SMUD- [www.smud.org](http://www.smud.org) is an excellent site to learn about conservation of energy and do an energy audit of your own home. SMUD's website also provides students with ways to be more energy efficient including some actions that don't require a huge amount of money from the homeowner's part. (for example: turning the AC temperature to 78 degrees in the summer months)

### Common Core Academic Standards

- 11-12.9. Draw evidence from informational texts to support analysis, reflection, and research. (A8.0)
- **Algebra A SSE:** 1) Interpret expressions that represent a quantity in terms of its context.
  - a. Interpret parts of an expression, such as terms, factors, and coefficients.
  - b. Interpret complicated expressions by viewing one or more of their parts as a single entity. *For example, interpret  $P(1+r)^n$  as the product of P and a factor not depending on P.* (A8.0, A10.0)
- **Graph a linear equation as well as a system of linear equations.**
- **Statistics and Probability:** 6) Evaluate reports based on data (A2.0, A8.0)

### CTE Pathway Standards

- A8.0 Implement processes to support energy efficiency.
  - A8.1 Understand the relationship between power and energy efficiency.
  - A8.2 Outline how domestic and industrial appliances and systems affect the environment, such as water units and heating and cooling systems.
  - A8.3 Compare costs of alternate/renewable energy sources, systems, and appliances and traditional energy sources, systems, and appliances.
  - A8.4 Conduct an energy audit.

### Lesson Plan Relevance To Externship

Students will learn about the different types of renewable energy sources which is exactly what I learned about on the externship when I had a tour of the Rancho Seco Nuclear Energy Plant and the Hydro Electricity Dams that I also visited. Energy audit of standard vs. for energy efficient appliances based on activities from the SMUD and Dept. of Energy website.

## Rubric for the Energy Audit Project

Student Deliverables	A. Knowledge	B. Individual Project Data	C. Individual/Partner Project organization
Not Proficient	Didn't find the slope or the y-intercept. Could not find the linear equation. Didn't identify the x and y in their table	Incomplete Date or incorrect.	Both partners didn't use time efficiently. Lots of talking. Lacked organization and neatness.
Basic	T-charts have minor mistakes which caused the graph if the system to be incorrect.	Mostly Complete but some mistakes in the calculations of the t-chart.	One partner did more work than the other. Didn't work as a team. Not very organized or colorful.
Proficient	T-chart and graphs are correct and they are color coded. No major mistakes and most questions correctly. Energy table is complete.	Completed most of the project with no mistakes. Calculations mostly correct.	Did all the minimum requirements. Pretty organized but not very neat.
Advanced	Above average knowledge about graphing systems. Showed how slope and y-intercept was found. Answered all questions correctly and the t-chart along with the corresponding graphs have no mistakes.	Went above and beyond what was asked from the project. All data set had no mistakes and all calculations were correct along with the corresponding graphs.	Excellent use if time and both partners did 50 % of the work as required. Color coded the t-charts with its corresponding graphs and very well organized and neat.

### Energy Efficient Appliance Energy Consumption Chart

The chart below shows the energy usage of high efficiency appliances that use approximately 15% less electricity than standard models. Using this information, determine how much money could be saved by using high-efficiency appliances in your home rather than standard models.

Appliance Type	Standard Appliance Wattage	High-efficiency Appliance Wattage	Difference in Wattage
Barbecue Grill	1350	1150	200
Dishwasher	1300	1105	195
Food Freezer (15 Cubic Feet)	335	285	50
Range	12500	10625	1875
Refrigerator/Freezer (Frost Free)	500	425	75
*Compact Fluorescent Bulb	60	15	45
Water Bed Heater	400	340	60
Washer	500	425	75
Television	80	70	10
Air Conditioner (Room) 6000 BTU	750	640	110
Air Conditioner (Room) 9000 BTU	1050	890	160
Air Conditioner (Central)	3500	2975	525
Electric Heater (Portable)	115	100	15
Furnace Fan Motor (Continuous)	350	300	50
Swimming Pool Filter Motor ¾ HP	1200	1020	180
Swimming Pool Filter Motor 1 HP	1500	1275	225
Ceiling Fan	60	50	10
Water Heater	3800	3230	570
**Computer, Monitor, Printer	200	170	30

## Energy Savings Calculations: Student Worksheet

Appliance to be Replaced by High-efficiency Appliance	# of Units	Difference in Wattage Between Standard and High-efficiency Appliance	Estimated use per month in hours	Wh/month difference
1.		(X)	(X)	
2.		(X)	(X)	
3.		(X)	(X)	
4.		(X)	(X)	
5.		(X)	(X)	
6.		(X)	(X)	
7.		(X)	(X)	
8.		(X)	(X)	
9.		(X)	(X)	
10.		(X)	(X)	
<b>Total kWh per month Difference</b>	<b>X</b>	<b>Multiplied by \$ per kWh</b>	<b>=</b>	<b>Total \$ Energy Savings Per Month</b>
		\$0.10 per kWh		

**kWh per month**

$$= (\# \text{ of Units}) \cdot (\text{Watt Difference}) \cdot (\text{Hours of use per month}) \div (1000)$$

**Total Energy**

$$= (\text{Total kWh per month Difference}) \cdot (\text{Price (\$) per kWh})$$

## Rule of Four Project: Energy efficiency

### 2) T- chart and equations for the fluorescent bulbs.

- $y = mx + b$  form equation for each chart
- Find slope
- Do two t-charts for 60 watt and 15 watt bulb.

### 1) Energy efficient Appliance Calculations Data sheet.

- Picked 10 appliances
- Calculations for the watt usage is correct
- Multiply the total kWh by the cost of kWh.

### 3) Graph a system of Linear equations from the t-chart above

- Label the x-axis as **hours** and the y-axis as **watts**
- Proper numbering of the y-axis
- Name for the graph and label each line ( $y = \underline{\quad}$ ).
- Color code with the chart above. (ie- pick chart goes with pink line on the graph)

### 4) Questions about Energy Efficiency

- a) Which bulb uses more energy and how do you know? Share some wattage information from your chart.
- b) If the price per kWh is **\$0.08**, then how much is the cost after 20 hours and 50 hours for the 60/15 watt bulbs? What is the difference in cost for each?

60watts $Y=60x$	After 20 hrs = $(1200)(.08) =$ \$96	After 50 hrs = $3000(.08) =$
15 watts		

- c) Use the purple paper and state the **cost saving** for you **after 1 year and after 5 years** of using energy efficient appliances. Based on the saving, does this encourage you to be more energy efficient in the future?

