ELEMENTARY SCHOOL ENERGY AUDIT CHALLENGE

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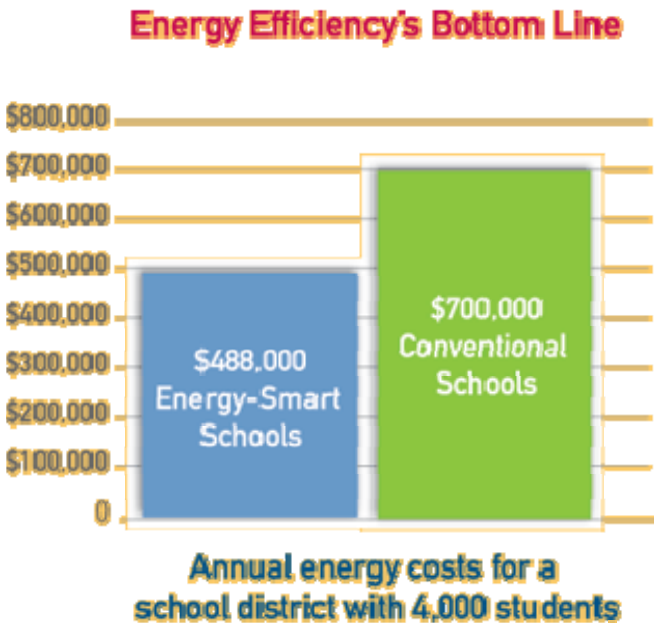


The chart above is based on current data observed and collected nationally by Energy Efficient Solutions, www1.eere.energy.gov/buildings/energysmartschools/plan.html.

This leads us to the question, how much could one of our schools here in Romeo save?

Elementary School Energy Audit Challenge

INTRODUCTION

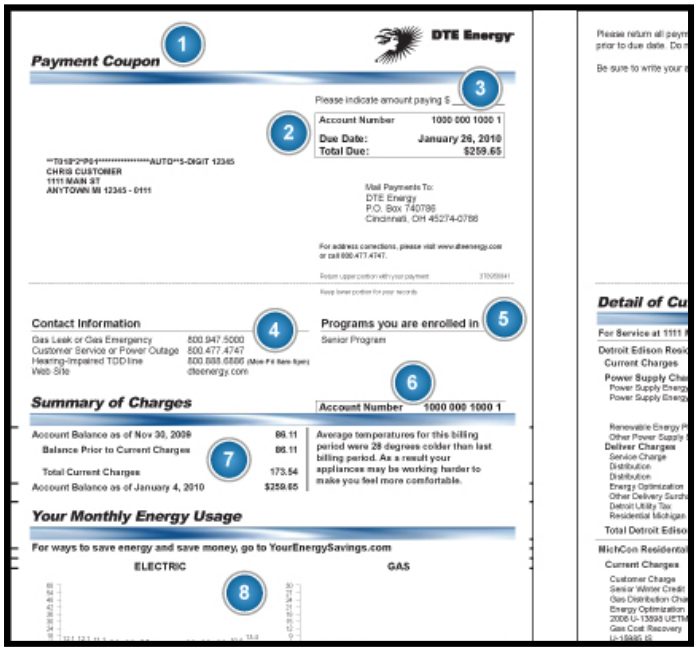
In this challenge, you will work as a member of a student team conducting an energy audit of one of Romeo's Elementary Schools. You will take scientific measurements, question students and school staff, and obtain various kinds of information related to how the school uses energy. As you finish each investigation, you will write a report with graphs and recommendations and present it to school officials. Your team's recommendations may cost the school little or no money and, if acted upon schools could save 2,5, or 10 percent of the previous year's energy bill. Is this a lot of money? In this study you will find out. Dollars saved may be available for such things as computers, athletic events, school functions, or for other school needs. Just as important, energy savings help the earth by improved energy efficiency, reduced consumption, and increased recycling and positive changes in transportation behaviors.

You will find that your school uses lots of energy, and that energy costs both money and the environment! Dollars are leaking out of your school every day, and it is up to you to find out the location and size of the leaks. Much like detectives investigating a crime scene, it is up to you to find the right people and get the information you need. As in any investigation, you will collect a lot of information, develop a list of suspects, organize your information, and present your findings along with recommendations.

Let's look at energy uses for an example school. At Roosevelt High School in Portland Oregon, the electricity, fuel oil, and natural gas bills for the 1993 school year came to $109,943. Of that, $73,199 was for electricity; $23,177 for #5 fuel oil; and $13,567 for natural gas. The electricity bill for November of 1992, just one month, was $6,544. What was the electricity used for? You probably will think of lights. But, what other parts of the school may use electricity? Where are other energy forms used in your school? These are the types of things you will want to think about.

A crime investigation is usually initiated with the discovery of a loss or injury. We are going to look into the possibility that an "energy crime" has been committed and energy is being wasted. We will look into this using two main methods; **Energy Accounting Audit** and a **Building Energy Audit**.

An **Energy Accounting Audit** is tracking your energy bills. Tracking expenditures helps prioritize where you should look first for savings, it enables you to measure whether steps you implement make a difference, and it permits you to spot unexpected anomalies that can lead to significant savings. We are going to look at gas, electric, water, waste and transportation. Savings are often available by simply reducing usage by the school.



The **Building Energy Audit** is the second major tool you will use. This involves going through your building to identify what is present. Where is energy being used, what type of energy, and how much is being used? How much solid waste is being collected from your school? Where it generated and what are its characteristics? You then compare what you have with the cost and savings possible with other options to recommend specific actions.

IN THIS ELEMENTARY SCHOOL AUDIT YOU WILL NEED TO:

(1) Collect data through interviews and do an **Energy Accounting Audit** and **Building Energy Audit**.
(2) Analyze the data from the audits (this will include graphing, correcting for climate and building usage, and calculating the economic cost-benefit of different alternatives).
(3) Make recommendations based on your findings.
(4) Create a visual report of your findings.
(5) Present your findings to school officials
(6) Educate elementary school students and faculty on energy usage, and lastly,
(6) Evaluate what recommendations are adopted and how much energy and money is saved.

Think about it

In addition to saving money, reductions in energy use has significant benefits for the environment. Energy use is damaging our environment. What can we do? Surprisingly, some of the solutions are quite simple. We can improve efficiency to get the same benefit while using less energy. The total number of CFLs in use globally nearly doubled between 2001 and 2003 alone, growing from an estimated 1.8 billion to 3.5 billion units. Substituting these bulbs for standard, incandescent lights will save up billions in dollars in energy, which is good news for not only the environment, but us the consumers. CFLs are far more efficient than traditional incandescent light bulbs because they produce less heat to create light, using about 75 percent less energy to produce the same amount of light and lasting up to 10 times longer. These energy savings translate into monetary savings. For example, a single CFL bulb can save up to $30 in energy costs in the United States over its lifetime; savings can be even greater where electricity costs are higher. Incandescent bulbs burn out after around 1,000 hours of use while CFLs can last for up to 10,000 hours, lowering their cost even without taking energy savings into account.
(www.worldwatch.org)

BUILDING AUDIT CHALLENGE – GENERAL QUESTIONER AUDIT (STEP 1)

The first step in the audit will be for you to give the key personal a general audit. This will help you to understand the building you are working with quickly.

Equipment and Information Needed:

1) Questioner answered by the person who is knowledgeable the "ins and outs" of the building.

Outcome Required:

1) Well answered questioner that will allow your audit team to make some possible suggestions that could save the school energy and money.

Following are questions you would want to ask to begin your building energy audit. What other questions can you think of that you may want to add?

General Questioner

1. When was the school built?
2. What additions have been made? When were they made?
3. What renovations have been made? When were they made?
4. What other facilities use energy on school grounds? Lighted athletic fields? Snack bars? Press box? Storage sheds? Outdoor lighting?
5. What kinds of fuels are used to provide energy to the school? For heating, cooling, water heating, lighting, other?
6. Are there other energy costs that the school pays for? Transportation?
7. How many hours is the school in use on weekdays? On weekends? In the summer? On holidays?
8. Do other organizations that use the school reimburse the school for energy use?
9. Who is in charge of controlling energy usage in the school? Do others have access to any of the controls?
10. Is there a system in place for regulating and monitoring controls?
11. Who is in charge of maintaining energy-using equipment? Is there a maintenance schedule for all energy using systems?

Building Envelope

1. What is the school building(s) made of? In what condition is it?
2. What is the roofing material? What is the condition of the roof? Are there any leaks in the building when it rains?
3. Is the building designed to make use of passive solar heat and light?
4. In which direction does the building face?
5. How many windows are on each side of the building? Are any windows cracked or broken?
6. What percentage of outside wall space do the windows encompass?

7. How many outside doors are there? Are the outside doors insulated? Are there windows in the doors? Are they double glazed? Are any cracked or broken?
8. Is the school building(s) well insulated? Walls? Ceilings?
9. Are interior stairwells open or enclosed?
10. Do windows and doors seal tightly, or do they leak air?
11. Are windows single or double-glazed? Can they be opened? Do the windows have adjustable blinds or curtains?
12. Are there awnings or overhangs over windows to shade windows from the overhead direct sun in warm weather, yet allow the slanted rays in winter to enter?
13. Are trees placed around the building to provide shade in warm months?

Heating/Cooling Systems

1. What kind of heating system is used in the school? What fuel does it use?
2. When was the heating system installed?
3. Does the heating system have a programmable thermostat to control temperature? What are the settings?
4. What kind of cooling system is used in the school?
5. When was the cooling system installed?
6. Does the cooling system have a programmable thermostat to control temperature? What are the settings?
7. Are there controllable thermostats in the classroom? If so, what temperature are they set at?
8. Is there an air exchange system when neither the heating nor the cooling system is operating?
9. Are the heating and cooling systems maintained on a regular basis?
10. Are boilers, ducts, and pipes insulated?
11. Does your school make use of passive solar heating?

Lighting

1. What kinds of lighting are used in the school? Outside the school?
2. Are lights and fixtures kept clean?
3. Can lights be controlled with dimmer switches? In which areas or rooms?
4. Does the school make use of skylights and natural lighting?
5. Are there automatic timers for any of the lights?

Water Heating

1. What fuel is used to heat water in the school?
2. Is there more than one water heater? How many?
3. When were the water heaters installed?
4. Do the water heaters have timers? What are the settings for each heater?
5. At what temperatures are the water heaters set?
6. Are the water heaters and water pipes insulated?
7. Are flow restrictors used?
8. Are there leaks in the hot water system?

Solid Waste and Recycling

1. Approximately how much trash does the school generate each week?
2. Does the school recycle? If so what items? *Check all that apply:* Paper, Plastic, Aluminum Cans, Glass, Other?
3. Approximately how many reams of paper are used a week in the school?
4. What is the recycled content of the paper used in the school?
5. Are both side of the paper used for printing?

Thank the person for their time to fill out the questioner.

ENERGY BASICS

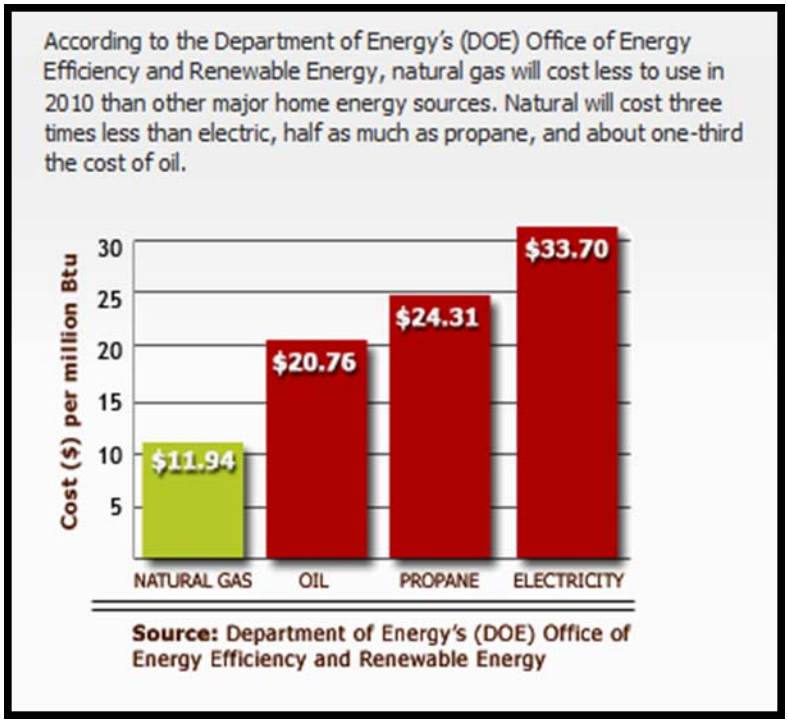
As a review, you should already know what the following terms and concepts mean.

Efficiency: How much useful energy you get out of a system to do work. An important point in this class is that efficiencies vary. For example, a car that gets 40 miles per gallon of gas is more efficient than a car that gets 20 miles per gallon of gas. To go the same distance, in the less efficient car you will burn twice as much gas as in a car that is twice as efficient. Since gasoline (energy) costs money, you will also spend twice as much money.

Energy Conversion Efficiency

Energy Conversion Device	Efficiency (% energy transferred)
Incandescent light bulb	**5%**
Internal combustion engine (gasoline)	**10%**
Human body	**20-25%**
Fluorescent light	**45%**
Fuel cell	**60%**

Fuel Cost: In addition to efficiency, often there are different types of fuels that can be used for the same task. For example, you could heat your house by burning $1 bills, $10 bills, or $100 bills in a woodstove. All would provide the same amount of heat, but use of $100 bills would cost 100 times the cost of using $1 bills. Using US paper currency, what would be the most cost efficient fuel to use?



Some schools have saved money by using equipment that could use the fuel that was least expensive at a given time. Energy cost however is only one of the factors that must be considered in considering which is best in a specific application. Other factors include the cost of the necessary equipment, convenience, safety, environmental impacts and other factors.

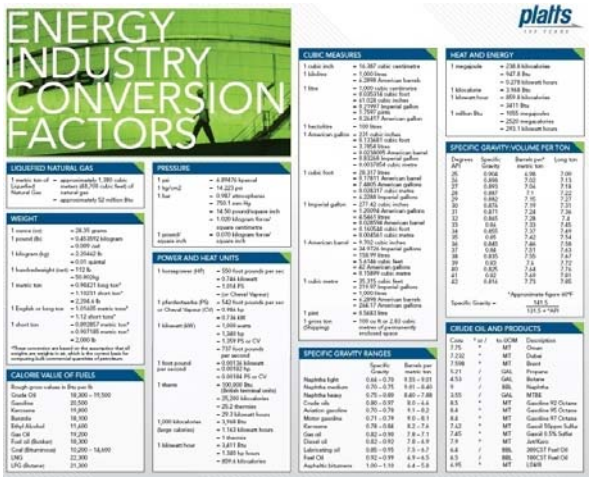
Energy Units: Developing a common basis for comparison is helpful. You probably have already encountered many of the ways energy is measured. The concepts of calorie, Calorie (Kilocalorie), British Thermal Unit (BTU), Therm and Kilowatt Hour all have to do with measuring amounts of energy. Many different units can be encountered when measuring energy use in a school. For an example, during the month of January, a school had made the following energy purchases:

Energy Source	**Amount**	**Cost**
Natural Gas	4,135.6 Therms	$2,144.31
Electricity	116,399.8 kWH	$6,563.40
#5 Fuel Oil	16,233 Gallons	$7,308.02
Total Energy Cost-January		**$16,015.73**

Investigative Questions #1:

From this one month of data (1/12) of a year, what do you think the total cost of energy for the year would be for this school?

Why would the month of January not be a good representative month?



To compare the use of different energy sources it is important to know the definitions of the different energy units and how to convert from one to another. Remember you want to compare apples to apples. Refer to your ***Energy Conversion Table***.

For example, how many kWh are there in 3 therms of gas?

According to the chart, 1therm= 29.3kWh
So, **3 therms** = *29.3kWh x 3* = **87.90 kWh**

By knowing that 3 therms= 87.9 kWh, as well as knowing the cost of gas verses electricity, you could tell someone how much is would cost them in electrical costs if they switched over from gas.

Working with conversions helps you understand how to convert from one unit to another. Understanding the price of the units is also important. Converting units may seem hard to do but you already know how to convert dollars into quarters, dimes, nickels and pennies. Energy conversions are similar, except that it is like changing dollars of foreign currency such as pesos (Mexico) or yen (Japan) into American dollars.

Investigative Questions #2:

For an elementary school in Romeo, how much are they paying for the following?

How much does a KWH cost? _____ (Go on-line to www.dteenergy.com.)

How much does a Therm of Natural Gas cost from Semco Energy? _____ (Go on-line to www.semcoenergygas.com or look at a school bill)

How much does a gallon of water cost? What about for sewer? _____ (Look at the school bill)

If a building's year total for Gas was 8,029 CCF, how many Therms is that? _____ (1CCF= 1.024 Therms

GETTING STARTED WITH THE AUDIT

All successful energy audit management programs have certain steps in common;

1. A system for tracking energy use in the building.
2. Knowledge of the features in the building that use energy.
3. A management strategy for reviewing and improving building performance.

These three steps must be undertaken, but there is no prescription for which must be implemented first, or specifically how they must be carried out.

Before you dive it to the audit, do some brainstorming to help you start identifying items that could play a factor in possible energy usage. With your team, come up with a list of the factors that you think are important in determining how much energy is needed to run a large building such as a school. Think about things that are related to energy use such as outside temperature, locating of the building, what the building is made of, and other features that determine how much electricity, natural gas, other fuel oil and water it takes to operate your school.

Investigative Question #3:

List items you can think of that could play a factor in the energy usage of a school building?

TRACKING ENERGY

Think about it

Tracking of energy use, through an **energy accounting audit** is a good place to start. The goal is to provide energy data in an organized and usable form so that sound business decisions may be made. By looking at past performance you can establish a baseline against which to measure your impact. You can identify areas of existing high energy use and use that information to prioritize where to focus your next efforts. Sometimes, by reviewing billing patterns you are able to identify problems that can immediately save the school money.

By comparing energy consumption with the average for similar buildings or for the same building over a period of time, it is often possible to identify when equipment begins to malfunction.

You will track the following systems for the elementary school;

1) **Electricity**
2) **Gas**
3) **Water**
4) **Waste Removal**
5) **Transportation**

A good example of the benefit of an **energy accounting audit** was one school's water bills. As their records were entered into a tracking program they noticed that summer usage did not significantly decrease even though the school was not being used. Investigating, they determined that a lot of the water "use" resulted from a water leak. Since sewage bills are based on the water bill, the school had been charged for sewage fees for water that was leaking into the ground and not going to the sewage treatment facility. Clearly the leak needed to be located and fixed, but the school was also received a refund of the money it paid for sewage treatment that it never used.

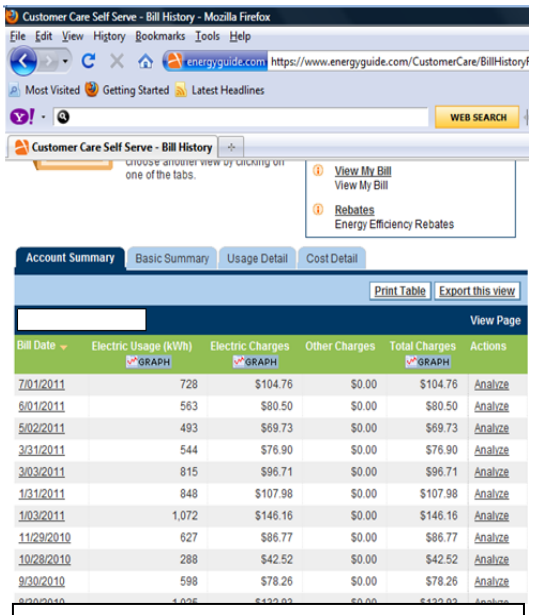
Getting the records for these items is a good place to start. To be successful you will need the support of office personnel in you school or district who have access to the utility records of your school. With their support and help from the utility service providers you should be able to understand how you are charged; something you need to know if you are to identify and prioritize different savings opportunities.

Use your team. Take advantage of different member's strengths to research and implement the tools you use to record the energy use data. Divide up the work equally and efficiently so the work benefits everyone and you can come back with a well put together report of information

Think about it

Energy accounting is something that every energy manager needs to do. In fact, there are a number of programs readily available to help organize the data. These programs can track multiple buildings and follow different energy forms and water usage. It corrects for weather variations and produces a number of reports and graphs enabling you to easily compare data from different time periods. However, along with the higher degree of sophistication, these programs can also require a significant amount of time, money and resources to input data. If you are only following one or two buildings, one typically does not need such a sophisticated program and can use a spreadsheet easily made up in Excel. Creating tables or charts enables comparisons between different time periods.

Potential resources for locating available tracking software include your state energy office, the facility managers responsible for the schools or district, or the local utility company. If your school or district has a Resource Conservation Manager (RCM), see them. They may already be tracking energy use at the school.



Bill Date	Electric Usage (kWh) GRAPH	Electric Charges GRAPH	Other Charges	Total Charges GRAPH	Actions
7/01/2011	728	$104.76	$0.00	$104.76	Analyze
6/01/2011	563	$80.50	$0.00	$80.50	Analyze
5/02/2011	493	$69.73	$0.00	$69.73	Analyze
3/31/2011	544	$76.90	$0.00	$76.90	Analyze
3/03/2011	815	$96.71	$0.00	$96.71	Analyze
1/31/2011	848	$107.98	$0.00	$107.98	Analyze
1/03/2011	1,072	$146.16	$0.00	$146.16	Analyze
11/29/2010	627	$86.77	$0.00	$86.77	Analyze
10/28/2010	288	$42.52	$0.00	$42.52	Analyze
9/30/2010	598	$78.26	$0.00	$78.26	Analyze

DTE has an on-line energy accounting system home owners can access and review their usage.

BUILDING AUDIT CHALLENGE – RECORDING ENERGY USES (STEP 2)

For the elementary school you are doing the energy audit for, complete the "ENERGY ACCOUNTING DATA CHART" spreadsheet in Excel to document the amount used and cost for Electricity, Water, Gas, and Waste.

Once you have imputing the information in the chart form, using Excel, graph the information in different ways to analyze the data further and see it in a different way.

ALTERNATIVE ENERGY

"INSERT SCHOOL NAME HERE" Energy Accounting Data
"Insert YEAR Here"

Information Compiled By:
"Students Names Listed Here"

Month	Electricity		Natural Gas		Water		Waste	
	Amount Used (kWh)	Cost $	Amount Used (Therns)	Cost $	Amount Used (Gallons)	Cost $	Amount Collected (Pounds)	Cost $
JAN								
FEB.								
MAR								
APR								
MAY								
JUNE								
JULY								
AUG.								
SEPT.								
OCT.								
NOV.								
DEC								
Total For The Year	0		0					

Total Electricty Used in BTU's	Total Gas Used in BTU's
0.00 BTU's	0.00 BTU's

Equipment and Information Needed:

1. "Energy Accounting Data Chart". Recording accurate data is critical.
2. Utility bills (for the designated year) showing usage and cost.
3. Information to understand how the bill is determined and how usage is converted to cost.
4. Remember you want to compare apples with apples so convert usages into like units.

Convert the usage into BTU's

Total amount of electricity used _____ KWH X 3413 = _____BTU

Total amount of natural gas used _____Therms X 100,000 = _____ BTU

Outcome Required:

1. Completed Energy Data Chart (Excel)
2. Usage amounts converted to BTU's
3. Graphic Charts explaining the Energy Data imputed.

Report your findings to your full group. Emphasize any anomalies or areas that you feel warrant further investigation.

Investigative Question #4:

How could you use the spreadsheet used above, and incorporate factors such as weather, or building activities, that would affect building energy consumption? List any other items you can think of that could play a factor in the energy usage of a school building that could be organized into a form of data?