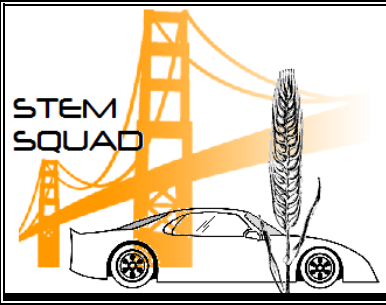

Energy Audit

Your local school board needs your help in developing an Energy Action Plan to "green-up" your school and reduce its carbon footprint. The goal of this project is to reduce energy costs by becoming more energy-efficient. Your primary objective will be to conduct an energy audit of your school's exterior and interior structure, as well as its mechanical systems, to locate areas for improvement.

DESIGN REQUIREMENTS

The Energy Action Plan must include a minimum of five action items

- Include a cost estimate:
  - Low to no cost
  - Moderate cost
  - Major capital expense
- Include an estimated timeline for completion:
  - Short term: 2–4 weeks
  - Mid-term: Within the current school year
  - Long range: 1–3 years (usually coincides with a major capital expense)
- Data from the energy audit must be representative of all areas of the school
- An estimate of potential energy savings must be given

TESTING EQUIPMENT

- Vernier data-collection interface
- Infrared Thermometer
- Light Sensor (not required if using LabQuest 2)
- Stainless Steel Temperature Probe (not required if using LabQuest 2 or the original LabQuest)

DELIVERABLES

- Recordings of ambient light and air temperature levels in major areas of the school
- Infrared (IR) scans of exterior and interior walls
- An assessment of your school's utility bills for electricity, natural gas, and/or fuel oil
- A proposal describing at least five action items that will improve energy efficiency

CONSTRAINTS

- At least one energy improvement can be implemented by students
- Recommendations must be made for all monetary levels
- The majority of action items should have a timeline of one academic school year or less

JUDGING CRITERIA

- Feasibility of action items
- Probability of implementation
- Data representation
- Potential cost savings

Teacher Information

OBJECTIVE

Students will conduct an energy audit to aid in developing an Energy Action Plan for reducing energy costs and improving energy-efficiency.

BACKGROUND

An Energy Action Plan is the foundation for reducing your carbon footprint and creating a greener school. Each time you turn on a light, the earth's natural resources are used. You can help to protect the environment and save your school money by creating an Energy Action Plan.

All good Energy Action Plans include an *energy audit*,an assessment of where and how your school uses energy. An energy audit should start with an analysis of your school's utility bills. All schools have a monthly base load of energy use for lighting, electronics, and hot water. Depending on your climate, you may also have seasonal loads due to heating and cooling. An energy audit will help you discover ways that your school uses energy and identify opportunities for reducing energy consumption. In addition, an energy audit will provide baseline data that will guide you in implementing future energy-saving strategies.

One type of energy audit involves a simple walk-through of your school making a visual inspection of your energy systems and recording ambient light and air temperature values. There are many easy ways you can save on energy just by knowing the light and temperature levels around your school. Switching out standard incandescent bulbs for compact fluorescents (CFLs) will yield the same light levels for one-tenth the power consumption. In addition, CFLs last about 10 times longer than incandescent bulbs, so your school will recoup additional savings in bulb replacement. Are you already using fluorescent bulbs? The metal grids inside many ceiling fixtures are meant to reflect and disperse the light throughout the room. Keeping those grids dust-free will significantly increase the reflectivity of the fixture. When conducting your lighting level assessment, you should record the data twice.The first time, collect data with lights on and the second time, turn the the lights off. You might notice that rooms with large window walls can often get by with natural lighting for some parts of the day.

The next step in your energy audit will be to scan windows, walls, baseboards, electrical outlets, and ductwork for significant temperature variations. An infrared thermometer works exceptionally well for this task, because it is a non-contact, fast-responding device that works by simply pointing the sensor at an object. IR scans can help you detect leaky doors, improperly-sealed windows, and poorly-insulated walls and ceilings. With this information, you can quickly identify the energy improvements that will yield the greatest benefit. Remember, the Second Law of Thermodynamics states that all objects will lose energy, but an IR scan can help you minimize the amount of energy that is lost.

EQUIPMENT OPTIONS

The Vernier LabQuest 2 or the original LabQuest are the best options for conducting an energy audit, because they are self-contained, portable, hand-held devices with long-lasting batteries. Both interfaces have a built-in sensor for measuring the air temperature levels. The LabQuest 2 also includes a built-in sensor for measuring ambient light levels.

The Vernier EasyLink and a TI graphing calculator also provide a portable data collection option, however the EasyLink does not have a built-in capability for measuring ambient light and temperature levels. You can use a Vernier Light Sensor and a Stainless Steel Temperature Probe for making these measurements, but you must factor in a little extra time for data collection. Measurements cannot be made simultaneously, because the EasyLink accepts only one sensor at a time.

Other Vernier interfaces, such as the LabQuest Mini, LabPro, Go! Link, or SensorDAQ can also be used to conduct your energy audit, but they must be connected to a laptop computer. In addition, these interfaces, like the EasyLink, do not have a built-in capability for measuring ambient light and temperature levels, so they require additional sensors.

The Vernier Light Sensor was designed for measuring reflected light from an object, rather than ambient room light. It should never be pointed directly at a light source or an open window. Instead, hold the sensor 20–30 cm above a desktop and point it at an open book. This method will give you the best reading for the amount of light available to students in the classroom.

TEACHER PROCEDURE

1. Instruct the class on the purpose of an energy audit. Students should be able to identify factors that influence how your school uses energy.

2. Analyze your school's utility bills for electricity, natural gas, and/or fuel oil. Create dollar cost versus time graphs for the last 12 months. Look for trends in energy usage.

Table 1: Monthly Utility Costs

Month	Electricity (kWh)	Cost ($)	Natural gas (therms)	Cost ($)	Fuel oil (gal)	Cost ($)
Jan						
Feb						
Mar						
Apr						
May						
Jun						
Jul						
Aug						
Sep						
Oct						
Nov						
Dec						

3. Record ambient light and temperature levels for major areas of the school, such as the main entry, the cafeteria, the gym, a science lab, and a typical classroom.

Table 2: Ambient Light and Air Temperature Levels				
Area	# Bulbs	Approx total wattage (W)	Light level (lux)	Air temperature (ºC)
Main entry				
Cafeteria				
Gym				
Science lab				
Classroom				
Other				

4. Collect IR scans of exterior and interior walls, especially those with lots of doors or windows. In addition, collect IR scans of baseboards, electrical outlets, radiators, room air conditioners, ductwork, and vents.

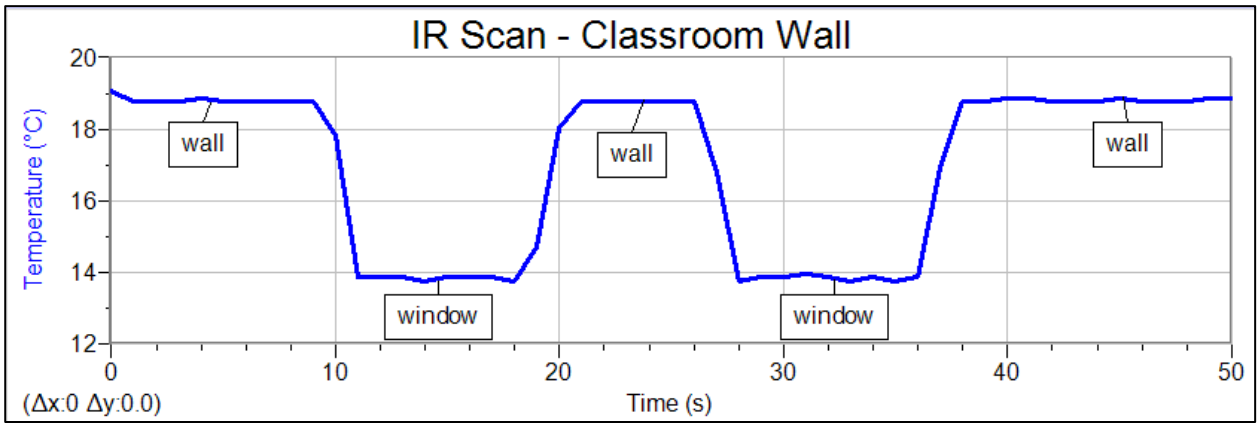

Figure 1

5. After analyzing the data, have students identify areas in your school that may be a concern for excessive energy consumption. Brainstorm ways to improve energy efficiency. Encourage students to be as creative in their solutions as possible.

6. Rank all potential ideas into three major groupings according to likelihood of implementation and cost.

7. Create an Energy Action Plan that includes at least five specific action items. Include a timeline, cost estimate, and potential cost savings for each item. This proposal should be in the form of a written document or a presentation.

Table 3: Energy Action Plan Summary			
Energy saving action item	Estimated hours to complete (hr)	Cost of implementation ($)	Estimated energy savings/yr ($)

8. After completing your Energy Action Plan, you may want to start an Energy Team. Develop a timeline for implementing some of your ideas throughout the school year. Attend a school board meeting to request funding for those ideas that cost money.

BACKGROUND

Moderate: 3–5 class periods

This activity requires 3–5 class periods to collect and analyze the data, and to prepare the Energy Action Plan. Additional time may be needed for presentation of the results to an outside audience.

RESOURCES

- www.earthday.org
- http://energy.gov/public-services/homes/home-weatherization/home-energy-audits
- www.energystar.gov/buildings/sector-specific-resources/k-12-school-resources