

Today I Learned About Energy Efficiency

“To stop climate change we need to switch off of using gas for heat and hot water. We need to stop using as much gasoline for automobiles and use more electricity for those things.

We need to encourage and move towards solar and wind energy as fast as we can. It's a lot easier to get there if you don't need as much [electricity]. If you find ways to reduce the entire electric draw in the system with energy efficiency, then you have a smaller hill to climb.”

Harvey Michaels, MIT Sloan School of Management

TILclimate podcast: Today I Learned About Energy Efficiency

A Warming Planet

We burn fossil fuels like coal, oil, gas, and natural gas to heat our buildings, move ourselves and our stuff around, and power our electric grid. Burning fossil fuels releases carbon dioxide (CO₂) into the atmosphere. This CO₂ acts like a blanket, trapping heat and warming our air and our ocean. A warming atmosphere and ocean are changing the climate, causing dramatic changes in weather patterns and other disruptions.

Energy Conservation vs Energy Efficiency



In the 1970s, the relatively inexpensive foreign oil that the US had been depending on suddenly became extremely expensive, or even impossible to buy. Energy conservation campaigns at this time focused on reducing fuel use by heating your house less, driving less, and turning off lights. Over time, the focus switched to energy efficiency – designing buildings, appliances, and vehicles to require less energy even under normal use. From the 1970s to the 2000s, most public information campaigns still focused on moving away from foreign oil sources towards oil and gas produced within the US.

Why Energy Efficiency Now?

Today, we know that we need to dramatically stop emitting CO₂ in order to avoid the worst effects of climate change. One part of that plan includes switching heating, vehicles, and appliances from gas to electricity. Hand in hand with that is to change how we get the electricity – using a mix of solar, wind, nuclear, geothermal, and other low-carbon sources. Energy efficiency today serves two purposes:

- In the short term, efficient buildings, vehicles, and machines will reduce fossil fuel use while our system is still heavily fossil-dependent.
- In the long term, reducing overall energy use will make it easier to replace high-CO₂ energy sources with low-CO₂ energy sources. If your building uses 50% of the energy it used to, you need a lot less new clean energy to run it.

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“We had gotten so sloppy about how we used energy because before that it had been so cheap that we used to insulate walls and homes in the 1930s and 40s, and then we stopped because it didn't seem like it was worth it.”

Harvey Michaels, MIT Sloan School of Management

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Energy Efficiency in Schools

The average public school building in the US was built in the 1960s¹ at a time when energy efficiency was not a major concern. Your school may be one of those, newer, or older. It may have gotten efficiency upgrades recently, or it may not. Through this exploration, you will learn a bit more about how your school runs.

Qualitative Audit

First, we're going to talk about how your classroom feels and what your own experience of the room tells you. This will help determine where your focus should be for the quantitative (numbers-based) audit.

Lights



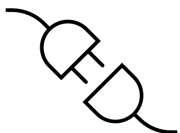
1. Are any of the lights too bright? Too dim? Flickering?
2. How often can you use daylight and turn off some or all lights?
3. What kind of lighting do you use in the classroom? (Fluorescent overhead? Smaller lamps?)

Heating and Cooling



4. How often is it too hot or too cold in the classroom?
5. Where does the heat come from in the room?
6. Where does cooling come from in the room?

Appliances & Electronics



7. What kinds of things are plugged in around the room?

Other



8. What else do you notice about how energy is used in your classroom?

¹U.S. Department of Education, National Center for Education Statistics, “Condition of Public School Facilities: 2012–13,” FRSS 105, 2013.

Today I Learned About Energy Efficiency

“Probably the biggest challenge is dealing with the need to do energy efficiency on a building by building basis over the entire world. We looked once and there were over a billion independent market actors in the building sector.”

*Harvey Michaels, MIT Sloan School of Management
TILclimate podcast: Today I Learned About Energy Efficiency*

Interview with a Custodian

Ask your school custodian, facilities manager, or whoever oversees the physical school building into your class. Before they come, prepare some questions ahead of time. Focus your questions on the biggest issues you noticed in your qualitative (feelings-based) audit. Once your class has decided on a set of questions, send them to your interviewee so they can prepare the answers before they come.

Interview Brainstorm

Use the following categories to brainstorm questions. You may want to split the class up into groups to focus on each category. Before the interview, decide who will ask which questions and who will take notes. You may also want to ask what is already being done or is planned in each of these areas to improve building efficiency.

1. **Lights** (types, efficiency, controls, etc.)
1. **Heating & Cooling** (energy source, efficiency, thermostats, etc.)
1. **Appliances & Electronics** (computers, cafeteria, other electronics, etc.)
1. **Overall School Building** (age, layout, systems, etc.)

Today I Learned About Energy Efficiency

“This is a three-part problem. There was one part which is what was technically possible to do, a second part of it, which was what really made economic sense, what would pass muster as something that was affordable. And the third part of it is, what would encourage people in big enough numbers to actually do it? What would incent people to change what they were doing?”

*Harvey Michaels, MIT Sloan School of Management
TILclimate podcast: Today I Learned About Energy Efficiency*

Make Your Recommendations

Based on your qualitative audit, your interview with a facilities manager, and your own research, make some top suggestions that could improve the energy efficiency of your classroom.

Consider *behavioral* improvements (actions you, your classmates, or your teachers can take) as well as *technological* improvements (equipment or physical upgrades.)

For more ideas, EnergyStar® has a checklist at

https://www.energystar.gov/buildings/tools-and-resources/checklist_common_energy_saving_measures

Communicate Your Recommendations

For each of your recommendations, consider who the decision-maker is. If you are suggesting improvements to the physical school building, this may be your principal, facilities manager, or superintendent. If you are focusing on behavioral improvements, your audience may be teachers, or your fellow students.

Design a communication strategy. Whom could you meet with? What would you need to show them, explain to them, or ask them for?

Financing Your Recommendations

For physical upgrades, your school district may need to find funding. Visit <https://www.dsireusa.org/> to find a list of incentives that might help your school afford the changes you have recommended.

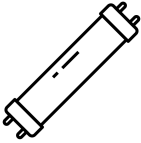
Energy Audit: Lighting

Lighting Types

Schools use a mix of different types of lights throughout the building. Some are more efficient than others and use less electricity. The most common types of lights are:



Incandescent Bulbs are the traditional lightbulb with a bright filament inside. They get very hot to the touch.



Fluorescent Tubes are long thin glass tubes filled with a gas that lights up when electricity is passed through it. These are most often embedded in the ceiling with a light-diffusing cover over them.



Compact Fluorescent Lightbulbs (CFLs) are shaped more like a traditional lightbulb but have a twisted tube inside filled with gas like a fluorescent tube.



Light-Emitting Diodes (LEDs) are tiny dots that release light. They can be used inside standard-shaped lightbulbs, as string lights, and almost any other shape.

Lighting Efficiency

Electricity is measured in *watts* as it is used by a light bulb (or other device.) Light is measured in *lumens*. The efficiency of a light bulb can be measured in lumens per watt. In other words, how many watts of electricity does it take to produce one lumen of light? A bulb with a high number of lumens per watt is more efficient, as it is producing more light for the same amount of electricity.

Bulb Type	Lumens per Watt
Incandescent Bulb	10-16
Fluorescent Tube	80-100
CFL Bulb	40-70
LED	60-80

Energy Audit: Lighting

Instructions and Definitions

Use the spreadsheet to collect data on what kinds of lights you see, how many, and how the lights are controlled.

Type of Lighting and Count: How many of each kind of light do you see? Note that many light fixtures may have more than one bulb or tube in them. Count all bulbs/tubes.

Wall Switches: Are there multiple wall switches so that just certain areas of the room can have the lights turned on? Or is there one switch for the whole room?

Ability to Turn Lights Off When There Is Daylight: If there is enough daylight to not need lights, are you able to turn some or all of the lights off?

Sensors: Are there any motion or photo sensors that control the lights? If the room is empty, do the lights turn off by themselves or stay on?

Lights On vs Off: Count the individual bulbs/tubes that are on and off.

Lighting Questions

After you complete your audit, answer the following questions:

1. What type of lighting is used most throughout the school?
2. Do classrooms have occupancy sensors (motion detectors or similar?)
3. Do offices have occupancy sensors?
4. Are there stickers reminding folks to turn off the lights when the room is unoccupied?
5. Is there enough natural light in classrooms to turn off some lights during the day?
6. What else did you notice about lighting throughout the school?
7. Based on the data you collected, what changes would you recommend your school make to reduce the electricity use of lighting?

Energy Audit: Heating and Cooling

Heating and Cooling Types

Depending on the age, location, and design of your school, heating and cooling may take a variety of shapes. The Heating, Ventilation, and Air Conditioning system of a building is called its HVAC system.

Ceiling Vents are mounted in the ceiling of a room, often in the same drop ceiling tiles as fluorescent lights. They push warm or cool air from a duct system throughout the school. They come in a variety of shapes but are generally square with openings in four or more directions.

Unit Ventilators are large rectangular boxes, usually under windows, with inflow vents near the floor and outflow vents on top. Blocking either set of vents reduces air flow and makes them much less efficient.

Baseboard Heaters are low along the wall just above the floor. They may have electric coils or a hot liquid inside them to heat the room. Blocking baseboard heaters makes them less efficient.

Instructions and Definitions

Use the spreadsheet to collect data on how temperature is regulated in the school.

Thermostat setting: There may or may not be a thermostat on the wall in each space. If there is, check what temperature it is set to. This is the temperature the heating/cooling system is trying to achieve.

Actual temperature: Using a digital thermometer, measure the actual temperature of the room. Measure in 3-4 different locations to get an average.

Blocked registers or grills: Are the vents through which heat or air conditioning comes blocked by books, bags, or other items?

Space heaters: If there are any portable space heaters in use, read the wattage on the back of the unit. Estimate how many hours a day it is used during the heating season.

Open windows: If heat or air conditioning is running in the room, are any windows open?

How does the room feel? Is it stuffy, drafty, cold, hot?

Energy Audit: Heating and Cooling

Heating and Cooling Questions

After you complete your audit, answer the following questions:

1. In general, did the temperature of the rooms match the thermostat setting? If not, were they warmer or cooler?
2. Are space heaters, small fans, or other devices being used to supplement or counteract the heating and cooling of the school?
3. Are air vents, heat registers, return grills, and other pieces of the HVAC system blocked?
4. Based on your answers, what heating and cooling related changes could your school make that would decrease energy use?

Energy Audit: Plug Loads and Appliances

Appliance Types

Using the list of sample appliances below, list the appliances you find in each room, the number of them, if they are turned on/off at night, unplugged or plugged in and their wattage rating. You can typically find the wattage on the back or bottom of the appliance.

Classroom Technology

Desktop computer
Monitor/Screen
Copier/Printer
DVD player
Television
Device charging station
Laptop
Projector
Scanner
Smart board

Comfort

Coffee maker
Fan
Lamp
Refrigerator
Hot plate
Portable air purifier
Portable humidifier
Portable heater
Aquarium/Terrarium

Other Appliances

Microwave
Dishwasher
Stove
Ice maker
Vending machine
Oven
Clothes dryer

Measuring Electricity Use

If available, use a portable electricity usage monitor (like a Kill-a-Watt) to measure the actual electricity use of the appliance. Refer to the instructions that came with your monitor and familiarize yourself with how to use it.

Instructions and Definitions

Use the spreadsheet to collect data on how appliances are used in the school. For each type of appliance, list how many there are and answer the following:

Unplugged: Is the appliance plugged in all the time, or only when in use?

Wattage: Either read the wattage off the back/bottom of the appliance or use a portable electricity usage monitor. If neither of these can be done safely, skip this step.

Powerstrip? Is the appliance plugged in to a powerstrip or surge protector with an on/off switch, so that it can be turned off completely when not in use?

EnergyStar® Appliances with the EnergyStar logo have been tested to be more efficient than other appliances of their same type.

Energy Audit: Plug Loads and Appliances

Appliance Questions

After you complete your audit, answer the following questions:

1. Are appliances and devices generally turned off at night?
2. Are appliances and devices generally unplugged when not in use?
3. Are any of these appliances EnergyStar rated?
4. Are any of these appliances plugged into a powerstrip that can be turned on and off?
5. Are there any appliances plugged in that do not get used?
6. Based on your answers, what appliance and device related changes could your school make that would decrease energy use?

Energy Audit: School Energy Behavior

Energy Behavior

While the biggest savings in energy come from replacing systems and improving insulation, the individual behaviors of people in the buildings add up. Making energy-saving behaviors a normal part of every day will significantly help reduce energy use.

For these observations, you may need to interview teachers, staff, and/or students.

Instructions and Definitions

Use the spreadsheet to collect data on how energy is used in the school.

Plug strips off: Many powerstrips have an on/off switch, meaning that everything plugged into them can be turned completely off at the end of the day. While some appliances and devices (refrigerators, fish tank filters, etc.) need to run continuously, most (computers, projectors, etc.) do not.

Lights off: Are the lights turned off in rooms that are not in use? It is a common misconception that fluorescent lights must be left on.

Computers off/sleep: If computers are not in use, they can be turned off or put into sleep mode. They should be turned off completely at the end of the day.

Other appliances off: Are there appliances/devices left on that aren't in use?

Blinds shut: Is there available natural light that is being blocked? Direct sunlight in a window can overheat the room, so blinds are a good idea at the time of day when the sun streams in. At other times of day, can daylight be used to replace some lights?

Acoustical issues: Sometimes people turn HVAC system parts off in a room because they are too loud. Note these issues – perhaps the noise can be fixed so that the HVAC system can be used more efficiently.

Energy Audit: School Energy Behavior

Energy Behavior Questions

After you complete your audit, answer the following questions:

1. Are school exterior doors or windows open during the day when the heat or air conditioning is running?
2. Do staff turn off powerstrips at the end of the day?
3. Are lights turned off when a room is empty or there is enough daylight?
4. Are computer monitors off or computers in sleep mode when not in use?
5. Are printers, scanners, and other tech turned off when not in use?
6. What behaviors could the school encourage to reduce energy use?

Energy Audit: School Energy Use Analysis

Energy Use

Ask your school administration for a copy of your school's energy bills for a year. If you are unable to get an entire year, work with whatever you can get.

Depending on how energy is used in your school, you may have an electric bill, a natural gas bill, or (most likely) both.

Instructions and Definitions

Copy the data from each month's bills into the spreadsheet.

Electric Use (kWh): Electricity is measured in kilowatt-hours. This is the amount of energy it would take to run one 1,000-watt appliance running for one hour. Depending on where you live, electricity is generated from some combination of burning fossil fuels such as coal or natural gas, nuclear power, and renewable resources such as solar, wind, and hydro-electric.

Electric Cost (\$): If available, write how much the school paid for electricity for this month. The cost of electricity may vary by month, day, or even hour.

Natural Gas Use (therms): Natural gas is a fossil fuel that is pumped out of the ground and moved through pipelines to be burned for heat or to generate electricity. One therm is 100,000 BTU, the standard measurement for heat. One BTU is the heat needed to raise 1 pound of water 1 degree Fahrenheit.

Natural Gas Cost (\$): If available, write how much the school paid for natural gas for this month. The cost may vary by month, day, or even hour.

Total Energy Costs (\$): If available, add the cost of electricity and gas.

Total Energy Use in kBTU: To compare electricity and natural gas, convert kWh and therms to kBTU:

1kWh = 3.412 kBTU

1 Therm = 100 kBTU

Your school may use some other form of energy, as well. For more conversion factors, use EnergyStar® Thermal Conversion Factors at <https://www.energystar.gov/buildings/tools-and-resources/portfolio-manager-technical-reference-thermal-conversion-factors>

Energy Audit: School Energy Use Analysis

Energy Use Questions

After you complete your audit, answer the following questions:

1. What is the average cost of electricity for one month?
2. What is the total cost of electricity for one year?
3. What is the average cost of natural gas for one month?
4. What is the total cost of natural gas for one year?
5. How much total energy (convert all to kBTU) does your school building use in a school year (not including summer break)?
6. Graph each month's electricity and natural gas use over a year. What patterns do you notice?

The total energy use per square foot over the course of a year is called an Energy Use Intensity, or EUI. This is the most common metric used in energy efficiency. You can use this to compare schools in the same district or other districts. An EUI is a great metric to use to set an energy reduction goal for your school! This is written in kBTU/square foot/year.

7. How many square feet is your school?
8. Divide your total kBTU for the year by the number of square feet to get your school's EUI.

Energy Audit: Group Analysis

Group Discussion

As a class, discuss the following questions. As each team's information is needed, report your overall findings.

1. Are there drafty areas in your school? Other issues where heat or air conditioning are uneven?
2. Did teachers, staff, and students seem aware of energy efficiency measures? If so, which were they actively employing? If not, how could we educate?
3. Lighting Team: What changes would you recommend your school make to reduce the electricity use of lighting?
4. Heating and Cooling Team: What changes would you recommend your school make to reduce the energy use of heating and cooling?
5. Plug Loads and Appliances Team: What changes would you recommend your school make to reduce the electricity use of appliances and devices?
6. School Energy Behavior Team: What behaviors could the school encourage to reduce energy use?
7. School Energy Use Team: What do you notice about your building energy use? Does it seem high? Does it seem low? What energy use goals might you be able to set to help measure the impact of the action items you choose?
8. Overall: What are the top recommendations you would make to the school administration to increase energy efficiency in your school building? Refer to page 4 for more on how to communicate your ideas.