Unit 2: Energy Conservation and Efficiency

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Unit Summary

In this unit, students will support their school's energy conservation efforts. These activities will help students ensure their school is doing its best to save energy (and $) throughout its campus. But before students break out their detective gear and dive into this investigation, preview this table below that maps the path to achieving the energy section of the certification.

Actions *Here are some actions students will take to complete the green@school checklist and reduce their school's environmental impact.*	1. **Research**—look up unknown words and concepts first! 2. **Become campus energy detectives**—check out classrooms, bathrooms, offices, cafeterias, etc. Interview relevant school and district staff to identify the types of lighting, appliances, and other energy systems on campus. 3. **Investigate energy hogs** on campus and identify opportunities for savings (money and kilowatts!)
Campaign Opportunities *There are several opportunities for student teams to raise awareness and educate their teachers and peers about the impacts of energy use (and waste!).*	1. Develop a network of "**Classroom Energy Monitors**" to stop energy waste in classrooms. Develop a checklist for the Energy Monitors of each classroom and a rotating schedule to give more students the opportunity to be Energy Monitors. 2. Develop **Energy Saving signage** to further spread the word! 3. Design an Energy Awareness **Campaign Pledge** for their school.
Skills *Here are some specific skill sets students may exercise across this program.*	1. **Get your math on**—calculate kilowatts and $ saved by gaining power of energy hogs in a single classroom. Chances are it will be the same in most classrooms on campus. 2. **Become a local advocate**—support students to educate their peers, instructors and administrators about energy conservation and efficiency and advocate for more efficient lighting, appliances, and systems at their school. 3. **Develop your marketing skills**—design effective signage to remind teachers and peers to turn off lights and appliances. 4. **Find your inner detective**— Find personal appliances on campus and determine their energy use (cell phones, desk lamps, microwaves, hot pots). Find new ways to make each classroom more efficient. (Is the thermostat blocked by anything? Can you replace a regular electrical strip with a smart strip? What draws energy in the classroom between 8am-3pm?)
Contacts *To evaluate campus energy use, students will have to build new outreach skills. Here the people you may want to help them contact.*	Energy Manger, Your School District Custodial Manager, Your School District Your school electrician **Who else? Have students develop their own list!**

Certification Checklist

As described in the green@school Handbook, each Unit corresponds with a targeted resource conservation goal and a specific section of the California Green Business Program's checklist, designed so that students will use this tool (the checklist) to assess their current campus environmental actions and identify opportunities for improvement (learn more at http://www.greenbusinessca.org/). This will occur following their deep dive into the subject through the lessons and activities shared in this chapter that seek to build their baseline knowledge on the subject before they are asked to become subject matter experts assessing their school's operations and practices. The checklist is included at the beginning of each unit so you can see what you're building towards, but again, know that its expected use will follow the activities and lessons shared below. Further, completing the actions in this checklist will enable your school to receive statewide recognition for your environmental leadership (bonus!). To assess the energy conservation and efficiency practices on your campus, walk through this list with your students, administrators, or other resource-relevant school site staff.

green@school Certification Checklist

#	Measure/Action/Practice	Does your school meet this measure?			Controlled by school staff administrator (SA), school district (D) or Students (ST)	Investigation Notes and Status
		YES	NO	DON'T KNOW		
Energy Conservation						
Reduce Your Energy Bill						
Required						
1	Replace incandescent bulbs with efficient compact fluorescents					

green@school Certification Checklist

#	Measure/Action/Practice	Does your school meet this measure? YES	NO	DON'T KNOW	Controlled by school staff administrator (SA), school district (D) or Students (ST)	Investigation Notes and Status
Energy Conservation						
2	Assign staff to track energy bills, checking for irregularities					
3	Replace all T-12 fluorescent lights with energy-efficient T-8 or T-5 fixtures with electronic ballasts or other equivalent efficacy lighting					
Equipment & Facilities						
Complete at Least 4:						
1	Replace single or package A/C unit with one that exceeds Title 24 building standards					
2	If purchasing new computers, buy EPEAT certified (www.EPEAT.net). If purchasing monitors, consider flat-screen LED monitors which consume approximately 1/3 less energy than larger ray tube monitors.					
3	Use ENERGY STAR® qualified refrigerators (those over 10 years old should be replaced)					

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green@school Certification Checklist

#	Measure/Action/Practice	Does your school meet this measure? YES	NO	DON'T KNOW	Controlled by school staff administrator (SA), school district (D) or Students (ST)	Investigation Notes and Status
	Energy Conservation					
4	Use task lighting instead of lighting the entire area					
5	If you are a large business or have a complex network, use power management software programs to automatically activate power management settings in computers and printers					
6	Use ENERGY STAR® office equipment and enable energy saving features					
7	Set thermostat to 76F for cooling, 68F for heating; use timing devices to turn system down after hours					
8	Use energy-efficient double paned windows on at least 90% of windows					
9	Apply window film to reduce heat					
10	Institute a policy that all electronic devices, lighting and room cooling units are turned off when not in use and place "turn off lights" reminders near switches					

green@school Certification Checklist

#	Measure/Action/Practice	Does your school meet this measure? YES	NO	DON'T KNOW	Controlled by school staff administrator (SA), school district (D) or Students (ST)	Investigation Notes and Status
Energy Conservation						
11	Shade sun-exposed windows and walls using awnings, sunscreens, trees or shrubbery					
12	Use a 365 day programmable thermostat to control heating and air conditioning					
13	Clean lighting fixtures, diffusers and lamps twice a year so they are lighting as effectively as possible					
14	When remodeling, design for or rearrange workspace to take advantage of areas with natural lighting					
15	Reduce number of fixtures or lamps per fixture					
16	Shade HVAC condensers, especially roof-top units					
17	Use occupancy sensors to control air conditioning/heat					
18	Use/maintain economizers to increase circulation					

green@school Certification Checklist

#	Measure/Action/Practice	Does your school meet this measure?			Controlled by school staff administrator (SA), school district (D) or Students (ST)	Investigation Notes and Status
		YES	NO	DON'T KNOW		
Energy Conservation						
19	Use a solar water heater or pre-heater					
20	Use instantaneous hot water heaters (or on demand systems) at point of use					
21	Use weather stripping to seal air gaps around doors and windows					

Student Learning Outcomes

The activities included within this lesson plan focus on building basic energy literacy, introduce some advanced concepts including energy efficient building design, and share opportunities for lighting, appliance and general energy conservation opportunities for students to apply at school and at home. After completing this unit, students will be able to:

1. Articulate at least three ways their school's built environment influences energy use.
2. Measure energy use of appliances and identify at least one energy-efficient technology for lighting, electronics and appliances.
3. State the difference between energy efficiency and energy conservation.
4. Communicate three ways they can conserve energy at home and at school.
5. Design a behavioral change campaign to engage and motivate peers, teachers, and administrators in their efforts to conserve energy on campus.
6. Implement energy saving initiatives on campus.
7. Name three career choices that relate to energy efficiency and/or conservation.

Lesson Plan

This unit provides students with the resources to explore the concepts of energy efficiency and conservation. Through interactive activities, campaigns and initiatives, students will be campus energy experts, empowered to investigate plug loads of appliances, interview teachers on energy consumption patterns, identify efficient (and inefficient!) lighting, and more! Students will reduce energy consumption at your school, saving money and reducing the emissions of greenhouse gases into our atmosphere, the known source of global climate change.

LESSON 1: ENERGY 101: ILLUMINATING THE BASICS

LESSON 2: DESIGN IT BRIGHT! ENERGY EFFICIENT BUILDING DESIGN

LESSON 3: GROWING GREENER: ENERGY CONSERVATION AND EFFICIENCY OPPORTUNITIES

LESSON 4: GETTING GREEN DONE: INFLUENCE PEERS, STAFF, FAMILY, COMMUNITY

A note to instructors: the plug-and-play activities shared throughout all green@school units are framed for your students, with the hope that you can simply offer/print these activities for their direct use. No extra prep time required!

Unit 2: Energy Conservation and Efficiency

Lesson 1: Energy 101: Illuminating the Basics

Building background in energy will help students build math, engineering, and communications skills while connecting them to the costs and inputs of operating a facility as complex as their school. Once gaining these fundamentals, students will work with school and district staff to become the implementers of change - transforming their school's energy hogs into energy saving success stories! From online activities to lively guest speakers, the following background study activities will ensure students have the knowledge required to make energy saving changes at school, and ultimately at home.

➢ Online Activity | *So What's Energy's Story Anyway? Exploring the energy basics with CEC Energy Quest*

To cover the basics, let's check out The California Energy Commission Energy Quest™ webpage (http://www.energyquest.ca.gov/). Find the answers to the following questions to get started towards building your new energy expertise!

Find definitions for the following terms using the link above.

1. **Energy:**
   _____
   _____
   _____
2. **Natural Gas:**
   _____
   _____
   _____
3. **Electricity:**
   _____
   _____
   _____

How is energy measured? **Find two real world examples** of an energy unit from the "**How Do We Measure Energy"** tab of the The California Energy Commission Energy Quest™ (http://www.energyquest.ca.gov/story/chapter01.html) webpage (i.e. one Btu equals about one blue-tip kitchen match).

Example 1: _____ **Example 2:** _____

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➢ Research Activity | *In the News: Schools and Energy*

In this brief reading activity, students will read a recent news article and discuss how energy policy has influenced K-12 schools in California. Feel free to use articles you've found instead, or ask students to find a current news article to expand their inquiry process and research methods ☺

From diminishing fossil fuel resources to renewable power, energy has been a hot topic for the last decade, talked about in articles and news reports all over the world! To combat the negative impacts of fossil fuel burning and over consumption of energy, national and state governments have targeted schools as a huge opportunity for energy savings. Here are a few articles that address energy issues in California that relate directly to schools.

1. The California Energy Commission, (2013), "Energy Efficiency Guidelines for School Funding Approved by Energy Commission" [Online]. Available: http://www.energy.ca.gov/releases/2013_releases/2013-12-19_school_energy_efficiency_guidelines_approved_nr.html[January, 2014].

2. How California's K-12 Schools Can Teach Us About Energy Efficiency (October, 2013) http://energyathaas.wordpress.com/2013/10/28/how-californias-k-12-schools-can-teach-us/

After reading the above two articles, answer the following questions:

1. How is California facilitating energy efficiency initiatives across its schools?

2. What is California doing that directly impacts you and your school?

Unit 2: Energy Conservation and Efficiency

➢ Research Activity | *Let's Get Political: What do energy policies and programs look like in California?*

Empower students as local research and policy experts by giving them time to research and discuss relevant state and local energy policies and programs. Resources on some of the most important state and local energy policies and programs and discussion questions are provided below.

California leads the country in energy efficiency and conservation policy! Now it's time to research some of the most important California energy policies. After you're done, research some relevant resources and programs that save energy in your community, also provided below.

Take a look into at least 2 of the following policies and 3 of the resources or programs listed below and discuss the following questions with the class:

Policies:

1. CALGreen (http://www.bsc.ca.gov/Home/CALGreen.aspx): California's Green Building Code
2. California's Renewable Portfolio Standard (http://www.cpuc.ca.gov/PUC/energy/Renewables/)
3. Cupertino's Green Building Ordinance (http://www.cupertino.org/index.aspx?page=1007)

Questions:

1. How does each policy save energy? Make sure to describe green building and renewable energy.

2. How does each policy impact you and your family?

3. Do you think each policy has been/ will be successful? Why or why not?

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➢ Research Activity | *Resources on Energy in California*

Resources: So many organizations, utilities and companies support energy efficiency in California. Check out the following to help answer the questions below and save them in your "resource bank" for additional background and support as you dive deeper into this unit.

- Pacific Gas and Electric (PG&E http://www.pge.com): PG&E is your utility company in Cupertino and one of the largest combination natural gas and electric utilities in the United States. PG&E is regulated by the California Public Utilities Commission (CPUC). Check out the PG&E's website to review your household energy bill and find out more about the company.
- California Energy Commission (http://www.energyca.gov): The CEC is California's primary energy policy and planning agency. The CEC website provides resources on efficiency, power plants, renewable energy sources, transportation, and more.
- The Bright Schools Program (http://www.energy.ca.gov/efficiency/brightschools/): This program of the California Energy Commission offers services to investigate the most cost-effective energy opportunities for K-12 school facilities. Check out their website to learn ways your school might team with the CEC.
- Green@Home Cupertino (http://www.acterra.org/programs/greenathome/cupertino.html): The City of Cupertino partners with the Palo Alto based non-profit Acterra to offer the Green@Home program. Sign up for a FREE online home energy assessment, powered by Bidgely, to learn more about your family's energy usage.
- Energy Upgrade California (https://energyupgradeca.org/county/santa_clara/overview): Sign up for the Energy Upgrade California Home Upgrade program to make home improvements that can save energy and make your home more comfortable.

Questions:

Narrow your new knowledge to answer the following:

1. How is one of the programs you reviewed related to energy use in your community?

2. What services does the program or organization you perused offer?

3. Name one way the program or organization could help your family save energy.

Above and Beyond: Find another relevant federal, state or local energy savings program to share with the class.

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➢ Professional Development Activity: Guest Speaker | *Green careers: What is it like to work in the energy sector?*

Expose students to green careers in energy by bringing in a guest speaker, such as your school district's energy manager, the school's staff electrician, or a local utility representative to speak with the students. Ask your green@school coordinator for suggestions and help to secure guest speakers. We're here to help!

Lesson 2: Design it BRIGHT! Energy Efficiency Building Design

In the U.S., almost 50% of our energy is used to power buildings![1] The way we build our buildings can use a lot of energy and fossil fuels and therefore contribute to climate change and air pollution. In realizing this, a new wave of "green building" strategies have arose to help ensure buildings are constructed to be more energy efficient, cost-effective and sustainable. As defined by the EPA, green building is the "practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life-cycle from siting to design, construction, operation, maintenance, renovation and deconstruction."[2] This lesson exposes students to some of the elements that make a building "green" and shares the many ways their school's built environment can affect energy use and ultimately occupant health..

Picture source

➢ Online Activity | *California Academy of Sciences Green Building Virtual Tour Lesson Plan*

Use this online activity (https://www.youtube.com/watch?v=PYF5OAHtSjI) to explore the elements of a green building (nope, it's not just the color—although there are a few plant covered examples shared here!) Want to dive deeper? Use the Earth Day Network (http://www.earthday.org/sites/default/files/What%20Makes%20a%20Building%20Green_Lesson%20Plan.pdf) and Edutopia (http://www.edutopia.org/green-building-curriculum-resources) Green Building Lesson Plans to share additional background information on green building design, construction and operations, lessons students will apply as they begin to navigate their green@school checklist.

[1] California Academy of Sciences, accessed on 05/12/14 at http://www.calacademy.org/teachers/resources/lessons/green-buildings-virtual-tour/.
[2] Environmental Protection Agency, accessed on 06/26/14 at http://www.epa.gov/greenbuilding.

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➢ Action Activity | *Building Design Tour*

Through this activity, students will investigate elements of their school's materials and equipment that influences its overall energy use, such as windows, HVAC, shading, and insulation. This activity helps students conduct the baseline assessment of several measures/actions/practices shared within the green@school checklist, which are listed on the tour worksheet attached. This activity is adapted from the Alliance to Save Energy's " Energy Map" Lesson Plan (https://www.ase.org/resources/lesson-plan-school-energy-map-3-12) visit their webpage to learn more.

In the U.S., 30% of a typical school's energy cost is expended on lighting, 14% on heating, and 41% on cooling.[3] These three energy uses are highly influenced by building design and, maybe surprisingly, by the location and orientation of furniture and technology. In this exercise, students will consider some of the ways your school's built environment is saving or wasting energy. Before beginning your investigation, brainstorm some ways energy can be conserved and/or wasted in class with the following activity.

With a partner, fill in the blank with "conserve(s)" or "waste(s)." Then, share answers as a class.

1. Opening the windows while the A/C or heat is on _____energy.
2. Weather stripping the doors and windows _____energy.
3. Sensors that turn off lights or machines when not in use _____energy.
4. Trees, awnings or shrubbery next to windows and walls _____energy
5. Single paned windows _____energy.
6. Leaving the lights on during bright sunny days _____energy.
7. Putting a bookshelf in front of the thermostat _____energy.
8. Task lighting_____ energy.
9. *Above and beyond:* Write your own and ask the class!

Instructor Answer Key:
1. Wastes; 2. Conserves; 3. Conserve; 4. Conserves; 5. Waste; 6. Wastes; 7. Wastes; 8. Conserves

[3] Alliance to Save Energy, accessed 07/10/14 at https://www.ase.org/resources/lesson-plan-school-energy-map-3-12.

Unit 2: Energy Conservation and Efficiency

Now that students know some of the elements of a building that can save energy, it's time to investigate the school's energy use due to its design, construction, materials and equipment. In teams, students will be assigned to specific locations throughout campus and will look for the following elements shared in the chart below. Use this chart provided to record your findings. For instance, check "yes" for the first measure/action/practice if the classroom has lights that turn off when no one is in the room (note: the equipment that enables this is called an occupancy sensor ☺). Check "no" if you have to manually turn off the lights (room could have switch and sensors that have been deactivated by the user ☹). Check "I don't know" if you are not sure. Some measures may not be applicable to some locations, and then you can write "N/A". Record any notes in the right hand column, as they will help inform your completion of the Energy Section of the green@school checklist!

LOCATION: _____

Chart Measure/Action	YES	NO	I don't know	Notes
Vending machine & lighting occupancy sensors				
Door/Window weather stripping				
Insulation around pipes, heaters, tanks, etc.				
365 Day Programmable Thermostat				
Sun-exposed windows shaded by shrubbery, trees or awnings				
Double-paned windows				
HVAC condensers (especially roof-top units) shaded				
Use A/C economizers				
LEED Certification				
Apply window film to reduce heat.				

Each team will present their findings to the class, highlighting the following:

- One way your school's location, materials, or equipment conserves energy.
- One way your school's location, materials, or equipment consumes or wastes energy.
- Your recommendations to conserve energy in your school.

Lesson 3: Growing Greener Energy Conservation & Efficiency Opportunities

In 2012, about 461 billion kilowatt-hours of electricity were used for lighting both the residential and commercial sectors—this is about 12% of total US electricity use![4] Because lighting makes up such a massive portion of our energy use, we can make a huge difference in combating climate change, preventing pollution, and saving costs by using lighting more efficiently. In this lesson, students will learn about different lighting types and their associated efficiencies, and, better yet, how to choose more efficient lighting for their school and home!

➢ Action Activity | *Watt Buster Challenge: Lighting Edition!*

Introduce students to different lighting types with this hands-on activity that empowers them to observe differences in incandescent, CFL, and LED lights as well as calculate the potential environmental and cost savings gained from more efficient options. Students will learn more about each lighting type in the next activity, the Lighting Audit. To support their learning, students will need access to a lighting board, kill-a-watt meter and calculator for this exercise. See the materials needed section of this document for guidance on how to access these tools.

In this activity, students will experiment with the lighting board and identify the most efficient and inefficient types of lighting. For each bulb (known formally in the industry as a "lamp" – checkout Power Sleuth to learn more about the parts of a light - http://www.powersleuth.org/teacher/energy-lights/lesson3-overview) students will test out, record the type of light (i.e. compact fluorescent (CFL), incandescent, light emitting diode (LED)), the light's wattage, and any observations they have during this assessment.

Type of light	Watts measured by Kill-A-Watt	Observations

[4] United States Energy Information Administration, accessed on 07/08/14 at http://www.eia.gov/tools/faqs/faq.cfm?id=99&t=3.

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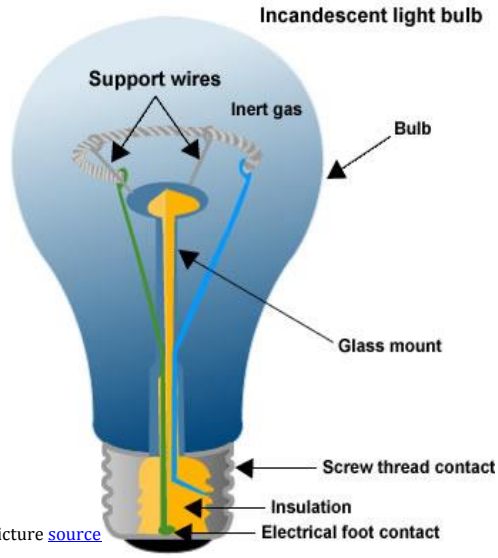
Get your math on!

Now it's time for a quick calculation. How much energy, money, and greenhouse gases would you save per day by replacing your incandescent bulb for a CFLs?



Picture source

Assume you use the light for 5 hours a day and at rate of $0.11 per kilowatt hour (kWh).

You can use the following equation:

$$\textbf{\textit{Cost}}\ (\$) = (\textbf{\textit{Wattage}})\left(\frac{1\ kilowatt}{1000\ watts}\right)(\textbf{\textit{hours used per day}})(\textbf{\textit{rate per kWh}})$$

Cost of an incandescent:_____
Cost of a CFL:_____
Avoided cost (Incandescent- CFL):_____

➢ Action Activity | *Lighting Audit: Fight the light at your school!*

In this activity, students apply their knowledge acquired during the Watt Buster Challenge and use it to investigate lighting across their campus. This activity helps students conduct the investigation required to conduct the baseline assessment of two measures within the green@school checklist, which require all commercial lighting used at your school to at least meet the efficiency of T8 or T5 fluorescent lighting with electronic ballasts and all other lamps to be CFLs or LEDs (i.e. desk lamps, "specialty lighting"). This complies with the California Energy Commission's energy efficiency standards that are codified in the most recent Energy Code (http://www.energy.ca.gov/title24/) and are based on international energy efficiency best practices in lighting technologies.

Light bulbs used in businesses, schools, and other large facilities may look very different than the standard bulbs in your home. Despite their different appearance (i.e. most commonly "tubes"), commercial/school lighting technologies are just as important and easy to identify as residential lights (i.e. standard incandescent bulbs, as represented in the graphic above, or "squiggly" compact fluorescent bulbs (CFLs)). Commercial lighting efficiency is determined by 2 different components—lamp type and ballast type.

Lamp Type *(from the Illuminating Engineering Society: http://www.ies.org/lighting/sources/index.cfm)*

- **Incandescent:** Produces light when its filament is heated by an electric current. Filaments are most commonly made of a coiled tungsten wire.
- **Halogen:** Incandescent lamps that operate at a higher pressure and temperature than standard incandescent lamps.

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- **Fluorescent:** Produce light by passing an electric arc through a mixture of an inert gas and mercury, which radiates UV energy that is transformed to visible light by the phosphor coating on the bulb. Fluorescent lamps have an efficacy 4-8 times that of an incandescent.
- **High Intensity Discharge (HID):** Produce light directly from the arc. Arc becomes extremely intense under high pressure. These lamps need ballasts.
- **LED:** Light-emitting diodes are electronic light sources. A semiconductor device emits visible light of a certain color (basically a type of solid-state diode that emits light when voltage is applied. LEDs become illuminated by the movement of electrons through a semiconductor material).

Picture source

Ballasts (*definitions from the Illuminating Engineering Society: see link above)*
"Provide necessary conditions to start and operate fluorescent or HID light sources."

- **Magnetic Ballasts:** Basically transformers made with a steel core that is wrapped in wire and placed in a metal can. Insulated wire, made of copper or aluminum, is coiled around the core. These components act to limit current and they also produce heat.
- **Electronic Ballasts:** Uses solid state electronic circuitry to provide proper starting and operating electrical conditions to power discharge lamps. Smaller, lighter and more efficient than a magnetic one.

Most commercial lighting uses **fluorescent lamps,** although you may come across some **HID** or **incandescent** (boo!) or **LEDs** (hooray!). As you have learned, fluorescent lighting was more efficient in the Watt Buster activity, so it's easy to assume that all commercial/school fluorescent lighting should be efficient, right? WRONG! Fluorescent lighting with electronic ballasts are much more efficient than fluorescent lighting with magnetic ballasts. Electronic high-frequency ballasts increase lamp-ballast efficacy, leading to increased energy efficiency and lower operating costs. Electronic ballasts are more efficient than magnetic ballasts in converting input power to the proper lamp power, and their operating of fluorescent lamps at higher frequencies reduces end losses, resulting in an overall lamp-ballast system efficacy increase of 15% to 20%.[5]

As you start your search, it's important to know that all fluorescent linear lamps are named with a "T" and then a number (i.e. T8). The "T" stands for tubular (shape of lamp) and the number gives the diameter of the lamp in eighths of an inch. (Learn more about T12, T8, or T5 lighting here: http://www.lrc.rpi.edu/programs/NLPIP/lightinganswers/pdf/view/LAT8.pdf).

Fluorescents with Magnetic Ballasts: T12s—tubular lamp with a diameter 1.5 inches.

Picture source

[5] Berkeley Law Applications Team, accessed 09/01/14 at http://ateam.lbl.gov/Design-Guide/DGHtm/electronicvs.magneticballasts.htm.

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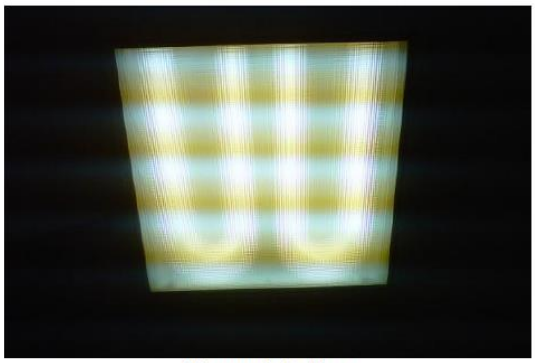
Fluorescents with Electronic Ballasts: T8s, T5s—tubular lamp with a diameter of 1 inch & 0.625 inches.

HOW CAN YOU DETERMINE IF A LAMP IS ELECTRONIC OR MAGNETIC?

Use a smart phone camera and hold it up to a fluorescent lamp, compare what you see to the following picture. If there are moving or flickering lights, it is magnetic (left image).



Magnetic Ballast

Electronic Ballast

Exit Sign Note: Many exit signs are now LED, like the photo to the right. In the audit, students will also be looking for the number of LED exit signs.

NOW LET'S GET STARTED!

Instructions: Split into teams. Each team is assigned a location (example locations given below). If unable to visit all classrooms, you can extrapolate based on the number of classrooms in the school.

In your assigned location, complete the following tasks:

1. Count the # of light tubes in the area (note: there are usually two tubes per ballast). _____

2. Use a smart phone or flicker checker (your green@school coordinator can share!) to determine if the ballast is magnetic or electronic. Circle the answer:
Magnetic Electronic

3. Identify the bulb size. You can usually determine this by simply looking at the size bulb or it is often stamped directly on the bulb – if you have good eyesight ☺ Remember, T12s are always magnetic, T8s and T5s should be electronic but sometimes the ballasts are incorrect). Circle the answer.
T12 T8 T5

4. Complete steps 1-3 if there is more than one type of light in your area.

5. Count the # of exit signs in the location. _____ Are they are LED? _____

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➢ Action Activity | *GUESS WHO…is the energy hog?*

Use this brief game to engage students around the concept of energy efficient appliances. Choose about five appliances you have access to (microwave, blender, coffee maker, pencil sharpener, printer, etc.). Have students rank the appliances they perceive will use the most and the least energy used (list least to the highest (watts)). Then measure the wattage of each appliance with the kill-a-watt meter and find whose guess is the closest.

Appliances, electronics, and lighting make up 44% of household energy use (can you say, energy hog?).[6] But do you know which appliances and electronics in your home are hogging all this energy? Play this quick guessing game and compete with your classmates to determine who your school's in-house energy expert is!

Instructions
Can you guess which appliance uses the most and least energy? Out of the appliances provided, rank those you perceive use the most (1) to least (5) energy. After you rank them below, monitor the appliance with your kill-a-watt meter (pictured) and find out how close you are.

LIST HERE:
1.
2.
3.
4.
5.

DISCUSSION:
Now that you've discovered which appliances are gluttonous energy hogs, let's discuss what surprised you. In small groups or with the class, discuss the following questions:

1. Which appliance uses way more energy than you thought?
2. Is there a pattern for which type of appliance use more energy than others?
3. How would the amount of time you use an appliance affect how much energy it uses?
4. Would this change some of your rankings? Or better yet, change your future use?
5. What other appliances are you interested in testing?

[6] Household Energy Use in California, accessed on 06/28/14 at http://www.eia.gov/consumption/residential/reports/2009/state_briefs/pdf/ca.pdf.

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➢ Action Activity | *Watt Buster Challenge: Vampire Edition!*

In this hands-on interactive activity, students will measure the energy used by various electronics and appliances and look out for vampire load (when an appliance still draws energy when in standby mode –learn more at How Stuff Works - http://electronics.howstuffworks.com/everyday-tech/vampire-power.htm). Here students will calculate energy use, cost, and associate greenhouse gas emissions resulting from the use of specific electronics and appliances.

Energy seems like an abundant, continuous resource always in supply, since you use energy pretty much all the time, right? Think about it – you flip a switch and the lights come on. You plug in your computer and you immediately have power. So if it's so easily accessible, why do we need to conserve it or use less? Well, while energy comes in many forms – electricity, gas, water, sun, wind, vegetation, fossil fuels—some of these forms (like fossil fuels) are non-renewable resources: meaning that someday we'll run out! So what can YOU do to save energy of this resource that's not in limitless supply?

One way you can make a difference is to reduce energy waste at your school and home. To do this, you must recognize how you can both use less (conservation) and do more with less (efficiency). During this activity, you will explore energy efficient technologies in lighting, electronics, and appliances and identify energy hogs (and energy-saving superstars!). "Vampire" appliances use electricity even when they are turned "off" by entering into a standby mode. You may notice that your DVD player still has a lighted clock even after you turn it off, or your radio may have a little red indicator light. On average, vampire appliances usually account for 5% of a home's TOTAL energy use (bananas!). Common vampire electronics, devices, or appliances include computers, instant-on TVs; surround sound systems, cable boxes, and household appliances that have a clock. You will visit the following stations, which are at various locations across your school, to measure how much energy is used by different devices.

A note to instructors: it's always a good practice to check in with the instructors or staffs overseeing that room before students descend to conduct their assessment of that room's equipment ☺).

Station 1: Classroom
Station 2: Library
Station 4: On Your Own (Quiz!)

Before students head out as energy investigators, let's illuminate (*pun intended*!) the subject a little further so they feel more empowered by their learnings during this technical assessment.

Unit 2: Energy Conservation and Efficiency

Energy – where is it & what does it look like?

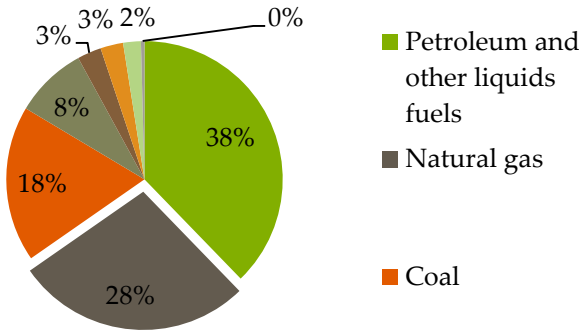
Energy causes things to happen all around us. Most often you can't see it but it comes in the form of electricity, gas, water, sun, wind, vegetation, fossil fuels. The sun gives out light and heat energy. Street lamps use electrical energy to light our roadways, sidewalks and bike lanes. A conventional car is powered by gasoline, a liquid energy. Even the food we consume contains (embedded) energy (don't believe us – check out this graphic to learn more!)

How is it measured?

Energy is measured in watts. A 60-watt light bulb will consume electricity at a rate of 60 watts. A medium-sized car might consume 100,000 watts. Many pieces of equipment come with power ratings to describe the rate at which they use energy.
Kilowatts (kW) – 1000 watts
Megawatt (MW) – 1000 kW
Kilowatts per hour – number of kilowatts in an hour – a measure of energy
Watts* Time Used / 1000 = kWh

Where does energy come from?[7]

- 15% - Renewable sources (abundant supply): sun, wind, water, vegetation, and internal heat of the earth
- 84% - Nonrenewable sources (Limited Supply): Fossil fuels



Electricity is also generated from nuclear energy. The United States is the world's largest supplier of nuclear energy, but construction of these facilities has ceased due to accidents, changing economics, and environmental issues associated with the disposal of "spent fuel" generated from these plants.[8] **Energy conservation** helps sustain resources for the future.

Name at least 3 activities you enjoy doing during the week. Can you do these activities without electricity?

1.
2.
3.

[7] United States Energy Information Administration, accessed on 07/11/14 at http://www.eia.gov/forecasts/aeo/er/table1.cfm.
[8] Wikipedia, accessed on 09/02/14 at http://en.wikipedia.org/wiki/Nuclear_power_in_the_United_States.

Unit 2: Energy Conservation and Efficiency

It's time for some detective work. During these activities, you will discover what devices are wasting energy and money on your campus. To measure energy use, you will use a device called a Kill-A-Watt Meter (pictured). This device can help you determine if you have a vampire appliance (one that uses energy even when it's off or in standby) or just a general energy hog. Here's how to use the Kill-A-Watt Meter:

1. Plug the meter into a wall outlet and plug the appliance into the meter. Leave the appliance switched off to measure for phantom load.
2. Read the meter and see if any wattage is being used. Make sure the device is measuring in watts (You may have to adjust the settings to do this).
3. Turn the appliance on.
4. Read the meter again and see if wattage has increased.

Station 1: Classroom

At this station, you will measure how much energy is used by different devices in your classroom. Common appliances used in the classroom include computers, projectors, pencil sharpeners…what else can you think of? After you measure the wattage with the meter, estimate how much time that device is used per day. Then use your math skills to calculate how much money that device is costing the CUSD energy bill!

Use the following equation for cost:
*(Energy used in Watts) * (Time used for one day in hours)* (Rate of electricity—about $0.11)/1000*

Appliance	Time used for one day in hours*	Watts (read from the meter)	kWh= watts*hours/1000	Cost (rate = $0.11) = (kW/hour)*rate
Example: Computer	*8 hours*	*450 watts*	*8*450/1000 = 3.6 kWh*	*3.6 kWh*.11 = $.40 a day or $2.00 a week*
Computer				
Projector				
Personal Heater				
Pencil Sharpener				
iPad cart				

TOTAL _____

Unit 2: Energy Conservation and Efficiency

What about climate change?
Choose one appliance you tested in the last activity. Calculate the greenhouse gases emitted in one day and per year as a result of using that appliance.

Appliance_____
Energy used in kWh (find in table above)_____
Lbs GHG = (Energy in kWh) (0.6389 lbs GHG/kWh)=_____

An average tree stores about 911 lbs of Carbon dioxide. The carbon dioxide (GHGs) resulting from your chosen appliance is the equivalent of cutting down how many trees?
(lbs GHG)/ 911 trees=_____
Note: this calculation is shared as often people can't visualize ghg, but trees or cars removed from the road (also a common calculation) are tangible ways to show the impact avoided or environmental gain of an action.

Station 2: Library
At this station, you will conduct a similar investigation but with appliances used at the library. You will also look at how much energy a computer uses in different settings (sleep mode, fully on, and fully off). Are the computers still energy hogs in sleep mode?

Appliance Setting	Time used for one day in hours	Watts	kW/hour	Cost (rate = $0.11) = (kW/hour)*rate
Sleep Mode				
On				
Off				

TOTAL _____

Unit 2: Energy Conservation and Efficiency

Station 4: Home Appliance Energy Quiz

Now that you've busted some watts on your school site, it's time to test your energy hog expertise. Match the follow appliances to their definitions. Then rank the appliances 1-10 from biggest energy hog (highest wattage) to least energy intensive (lowest wattage).

Appliance	Rank	Who am I?	How do I use energy
Television			A. I use energy to spin and keep you cool
Stereo			B. Even though I am always plugged into an outlet, energy is consumed only when I am turned on to heat food.
Refrigerator			C. I use energy to produce pictures on a screen.
Washing Machine			D. I use energy to rinse and spin.
Water Heater			E. I use energy when I am plugged in and turned to a certain temperature.
Range Top Stove			F. I use a large amount of energy derived from electricity or gas to cook food.
Ceiling Fan			G. I use energy to receive radio waves in your home.
Toaster			H. I use a lot of energy because I am always cooling and freezing.
Iron			I. I use a large amount of energy so that you can take warm showers and have hot water
Microwave			J. I use energy to heat coils that cook your food

Lesson 4: Getting Green Done: Influence Your Peers, Staff, Family, & Community

Diminishing fossil fuel resources, growing climactic changes, increasing air, water, and land pollution are just the few of the daunting impacts and concerns associated with the way we use energy. But how can you and your school act to address these huge and growing problems? The Campaign and Initiatives section of this unit aims to guide students through effecting behavior change and implementing energy saving initiatives on campus, a skill that can be taken home or applied across the community in student's future work as change agents.

Campaign Ideas

Do your students need some help getting started as they campaign their peers and teachers to change their behaviors and transform energy hogs into energy-saving superheroes? Here are a few campaign examples to get your class started:

- **Classroom Energy Monitor Program** | Students create a rotating network of classroom energy monitors who ensure all appliances are shut off at the end of each day. (Hint: ask the district energy manager for pointers!)
- **Energy Saving Signage** | Students develop reminder signage for light switches, appliances, printers, etc. Ask your green@school coordinator for templates or search online for ideas to create your own –they're abundant!
- **Pledge Campaigns** | Students can run their own lunch-time pledge campaigns, asking peers and teachers to pledge their commitment to conserving energy. This works best if you use concrete examples for the pledges. This can be easily turned into a competition between classes or individual students.

Initiative Ideas

Want to change equipment on campus, or lobby the administration or district to do so? If you need district or administration approval, use the memo templates included within our instructional toolkit. Here are some examples of energy saving initiatives you can make happen at your school:

Smart strips for classrooms | Based on your Energy Efficiency Scavenger Hunt and Watt Buster Challenge experiences, have you determined that your campus appliances are certifiable energy hogs? If you can't get new appliances, you can make sure appliances are used as efficiently as possible. One way to do this is to use power strips, or better yet, smart strips in all your classrooms.

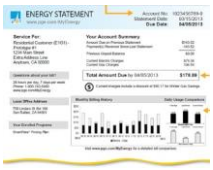
Lighting Upgrades | Did you find inefficient lighting on campus during your lighting audit? If your campus still has any T12 or other inefficient lighting, it's the perfect time for an

upgrade! Ask your district energy manager what you can do to make lighting upgrades happen at your school.

Energy Management System | Many schools are now on something called an "Energy Management System," which is basically a software program that helps your school better control energy use on campus. Find out if your school uses an EMS, and if not, ask the energy manager how you can help.

Materials Needed

To complete various activities in the Unit 2 lesson plan, you will need some tools and materials:

Tool	Picture	Description	Where you can get it
Kill-A-Watt Meter		A pun on "kilowatt" (a unit of power), the kill-a-watt meter measures energy used by appliances plugged directly into this device. Can measure voltage, current, energy consumed power. Watch this short youtube video to learn how to use this device.	Cupertino library: checkout Library: 10800 Torre Ave http://www.sccl.org/ Or from green@school: City Hall: 10300 Torre Ave (408)777-3362 sustainability@cupertino.org
Calculator		Any simple calculator will do!	Ask your peers or teacher. Cellphones work too!
Lighting board *(optional)*		Displays several lighting types of varying efficiencies connected to a kill-a-watt meter. Compares the energy use of CFLs, LEDs, and incandescent bulbs.	You can check out a lighting board from green@school. 10300 Torre Ave (408)777-3362 sustainability@cupertino.org
Various electronics		Plug electronics into kill-a-watt meter (i.e. coffee pot, computer, monitor, pencil sharpener, printer, microwave, etc.)	Whatever is available at your school!
Flicker Checker (Or smart phone with a camera!)		Use a flicker checker or smart phone camera to determine if commercial fluorescent lights have electronic or magnetic ballasts. (This will be explained in a later activity)	Check one out from your green@school coordinator, or use smart phones. 10300 Torre Ave (408)777-3362 sustainability@cupertino.org
PG&E account or Energy Management Software *(optional)*		Access a utility bill to investigate your home or school's energy use and cost. Check with your school's energy manger to see if they have energy management software to analyze class-by-class energy use.	Ask parents for your home bill. School utility bills are maintained by the District. CUSD Energy Manager (408)252-3000
Blank campus map		Keep track of lighting/ appliances on map for easy data collection.	Ask your school office for a blank map.