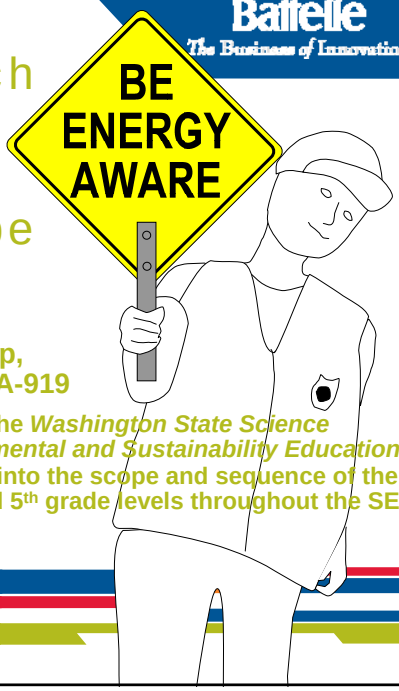
Energy Awareness:

A consumer approach
What is energy?
Why is it important?
Why should energy be conserved?

Lesson Plan for grades 4-5

Post-Nov 18 ESD123/LASER Workshop,
ERICA Information Release #PNWD-SA-919



These lessons were designed to align with the *Washington State Science Learning Standards* and *Integrated Environmental and Sustainability Education Learning Standards*. These lessons also fit into the scope and sequence of the STC *Electric Circuits* Unit used at the 4th and 5th grade levels throughout the SE LASER Alliance

VERSION DATE: 1/6/11

Workshop Overview & Schedule

- *See schedule slide in the Workshop PowerPoint file for Grades 2-3.*

Funding & Strategic Mission

- The Washington State Attorney General Office (AGO) funded Battelle to investigate ways to increase energy efficiency awareness in the K-12 student community.
- Based on guidance from several teachers and curriculum developers/organizations, we developed energy efficiency lesson plans to support the Washington State Science Learning Standards and the Washington State Integrated Environmental and Sustainability Education Learning Standards.

Overview of Student Instruction

- About 30 minutes a day for 4 days (not necessarily in a row).
- Day 1:
  - Pre/Post Energy Survey (10-15 minutes)
  - Energy Name Game (10-15 minutes)
- Day 2: “What Keeps Me Warmer?” (thermometers) (30 minutes)
- Day 3: “How Much Does It Save?” (“EZ Watt” meters) (30 minutes)
- Day 4: Home Energy Survey - homework. (5-10 minutes).
- Day 5:
  - Follow-up on the Home Energy Survey. (15 minutes)
  - Post-survey: redo the Energy Survey (15 minutes)

Teacher's Options

- Designed into two grade-groupings (2-3 and 4-5) per state curriculum standards – but teachers pick which components of this lesson plan to use in classroom.
- Download Battelle's PowerPoint slides to modify as desired. (Note our Disclaimer slide.) http://buildingefficiency-labworks.pnl.gov/education_k-12.stm
- Ask your district, LASER, or ESD science curriculum leaders about additional training on this lesson plan, on this general subject, or about finding an energy scientist/engineer to visit your class.

Science Standards - Grades 4-5

Washington State Science Learning Standards: Note: *also addresses some standards from math, social studies, &economics*

EALR 4: Physical Science

Big Idea: Energy: Transfer, Transformation, and Conservation (PS3)

Core Content: Heat, Light, Sound, and Electricity

Time: about 60 minutes a day for 5-6 days or adaptable to class time

Washington State Integrated Environmental and Sustainability Education Learning Standards: Standard 3: Sustainability and Civic Responsibility *Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability.*

National Science Standards:

- *Sun is main source of energy*
- *Energy comes in many forms: fossil fuels, oil & coal*
  - *Such fuels come from plants that grew a long time ago*
- *Cost effectiveness and pollution issues with energy, which sources cost more and which sources pollute*
- *How do we conserve energy?*

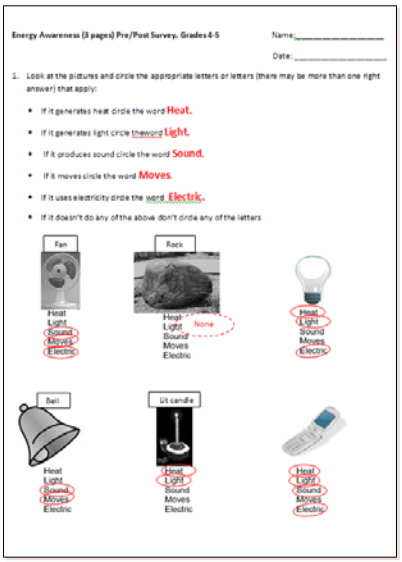
State Content Standard & Performance Expectation, Grades 4-5

- Energy has many forms, such as heat, light, sound, motion, and electricity.
  - Identify different forms of energy in a system.
- Energy can be transferred from one place to another.
  - Draw and label diagrams showing several ways that energy can be transferred.
- Heat energy can be generated in many ways. Heat moves from warmer things to colder.
  - Identify several ways to generate heat energy.
  - Give examples of two ways that heat energy can move.
- Sound energy can be generated by making things vibrate.
  - Demonstrate how sound can be generated by vibrations as it moves to your ear.
- Electrical energy in circuits can be changed to other forms of energy.
  - Describe how electrical energy is transferred and converted.

Classroom Activities

Activity 1: Energy Survey

- Give the pre-survey on energy. Note – use this same survey at the end of the lessons to evaluate student learning.
- If you are viewing these PowerPoint slides in Battelle's original PowerPoint file, then you can click on the following PDF file icons to open the PDF of the survey.
  - Survey:
  - Survey Answers:
- If you have downloaded the files from the Battelle webpage, then use the Word .doc or Acrobat .pdf files named 'survey' and 'survey answers'.


Energy Awareness (3 pages) Pre/Post Survey, Grades 4-5

Name:_____

Date:_____

1. Look at the pictures and circle the appropriate letters or letters (there may be more than one right answer) that apply:

- If it generates heat circle the word Heat.
- If it generates light circle the word Light.
- If it produces sound circle the word Sound.
- If it moves circle the word Moves.
- If it uses electricity circle the word Electric.
- If it doesn't do any of the above don't circle any of the letters

Fan Heat Light Sound Moves Electric

Rock Heat Light None Sound Moves Electric

Heat Light Sound Moves Electric

Bell Heat Light Sound Moves Electric

Lit candle Heat Light Sound Moves Electric

Heat Light Sound Moves Electric

Vocabulary/Spelling List of Learning:

these are the energy related terms that accompany the lessons. Use these as desired.

appliance	**battery**
Celsius	**electric circuit**
conserve	**consumer**
electricity	**energy**
Fahrenheit	**fluorescent**
generates	**graph**
heat	**incandescent**
infrared	**kilo**
kilowatt	**light**
motion	**sound**
temperature	**watt**

Activity 2: Name Game

"They Call Me Mr./Miss Energy"

- Play this group game to get the students thinking about energy.
- See suggestions and flow of game in the Notes section of this slide in the PowerPoint file.
- Student "A" picks an energy name for himself and the student to the left recites that Student A's name and then picks a energy name.
- The following slide show possible names in the slides and Notes section of the slide. The slide includes background information on some of the energy names and concepts.

Activity 2: Name Game – Name List

A. Amp – short for ampere- measures the amount of electricity moving through a wire. Amps are what give electricity its "shock". Named after physicist Andre-Marie Ampere (1775-1836). Acceleration

B. Battery, Biodiesel, Biofuel, Biomass

C. Conductor – A material that allows electricity to flow through easily. Most metals are good conductors of electricity. EX. That is why copper is used for electrical wiring inside your home. Coal, Carbon, Capacity, Current

D. Diesel

E. Energy Conservation – Using less energy. "Conserve" means to "avoid using". EX. Turning off a light. Efficiency, Electron, Energy, Ethanol, Energy of Motion

F. Fossil Fuel – Coal, oil, and natural gas are fossil fuels. Over time, tremendous amounts of heat and pressure created by the layers of the earth turned animal and plant matter into natural gas and petroleum (oil). Fuel cell, Frequency, Force

G. Geothermal Energy – "Geo" is Latin for "earth", and "thermal" means heat. We take the heat from the ground and use it to keep our homes, schools and other buildings warm. Gas, Generator, Geothermal.

H. Hydroelectric power – "Hydro" is Latin for "water", hence it is made from the flow of water in a river. EX. When the river flows over the dam, the force of water spins big fan blades inside the dam. The fan blades, or turbines, turn the magnet inside the generator to create electricity. Heat, Hybrid.

I. Insulator – A material that slows or stops the flow of electricity. EX. Special gloves and sleeves that utility workers wear are made of rubber, which is a good insulator to protect them from electric shock. Internal combustion engine

J. Jet fuel, Joule

K. Kilowatt - One Kilowatt equals 1,000 watts ("kilo" is Latin for "thousand"). This is how electric companies measure how much electricity your family uses at home.

Kinetic Energy

L. Light, Laser, Lightning.

M. Megawatt, Mining, Motor, Motion, Momentum, methane

N. Nova – a star that releases a tremendous burst of energy. Natural gas, nuclear power

O. Oil

More names in the Notes section of this slide.

Activity 3:

"What keeps me warmer?"

Materials per group (total of 2 groups):

- 3 thermometers (6 total)
- 1 small bag with denim material in it (2 total)
- 1 small bag with fleece material in it (2 total)
- 1 instant ice pack (2 total)
- 1 record sheet (2 total)

Figure 1: Bags with Insulation placed over thermometers

Figure 2: Cold pack placed over insulation and thermometers

Activity 3 Cont'd: Record/Log Sheet
Print out for each student's recording...

Table 1: Activity

Material	Initial temperature (temperatures should be the about the same)	Final temperature

Table 2: Example Record/Log Sheet

Material	Initial temperature (temperatures should be the about the same)	Final temperature
Denim	72	52
Fleece	72	47

Activity 4: How Much Does It Save?

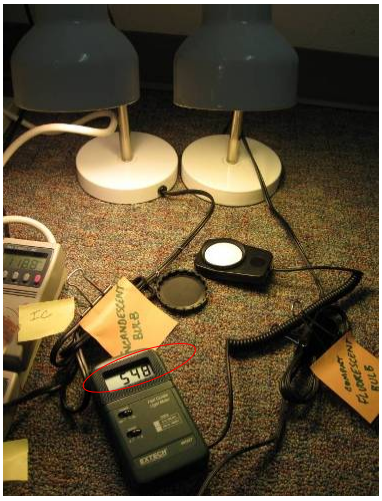
Materials:

- 2 lamps
- 1 incandescent bulb
- 1 compact fluorescent bulb
- 2 Kill-a-watt ™ EZ meters
- 1 outlet plug strip
- Post it notes and ruler (not provided)

Set-up:

1. Place lamps on floor/table.
2. Screw in the incandescent (IC) bulb into a lamp.
3. Plug that lamp into one of the Kill-a-watt TM EZ meters and label that meter “IC”.
4. Screw in the compact fluorescent bulb (CFL) into the other lamp.
5. Plug the lamp with the compact fluorescent bulb into the remaining Kill-a-watt ™ EZ meter and label that meter “CFL”
6. Adjust height of each lamp ~8” off floor/table.

Activity 4 Cont’d :



Light meter reading and comparison

Set-up cont’d:

7. Reset the Kill-a-watt ™ EZ meters
8. Turn on each bulb at the same time
9. The meters will start taking readings immediately
10. Unscrew the cap off the light meter
11. Set the light meter under the IC lamp
12. Set meter to Range “B”
14. Turn meter to on and observe reading
15. Set the light meter under the CFL lamp
16. Turn the meter on and observe reading
17. Notice that the readings are about the same (results will vary depending on height of lamps off floor and meter placement.
18. The packaging of the two bulbs can be compared (foot candles should be about the same, these lamps showed 548 and 560.)

Activity 4 Cont'd:

"How much does it save?"

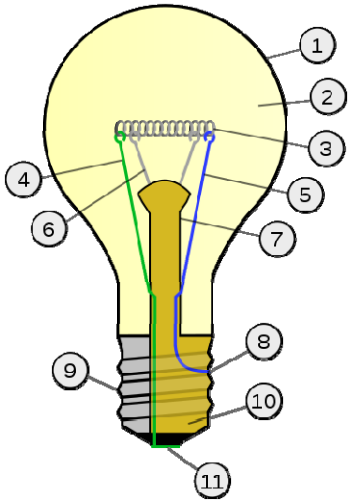
- Record the energy (kWh) off the each IC meter and put the value in column #1
- Record the energy (kWh) off the each CFL meter and put the value in column #2
- Subtract column #1 from column #2, record in column #3
- Show savings in column #4; Multiply fixed rate ($0.057/kWh*4380 hrs/y)

Energy measured Lamp with IC Bulb (kWh)	**Energy measured Lamp with CFL Bulb (kWh)**	**Energy difference (0.04-0.01, kWh)**	**Annual Savings ($) ($0.057 * 4380 hrs/year) if assume lamp is "on" 12 hours per day)**
0.01	0.04	0.03	$ 7.5

Activity 4 Cont'd: Record/Log Sheet

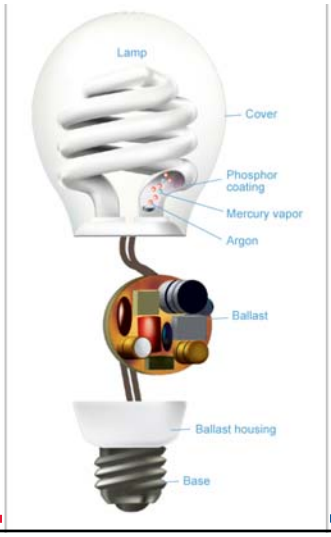
Energy measured Lamp with IC Bulb (kWh)	**Energy measured Lamp with CFL Bulb (kWh)**	**Energy difference (kWh)**	**Annual Savings ($) ($0.057 * 4380 hrs/year) if assume lamp is "on" 12 hours per day)**

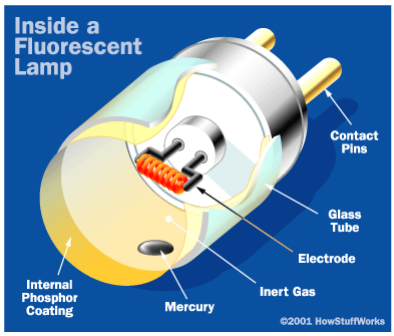
Activity 4 Cont'd: Additional Information Incandescent Light Bulb Technology



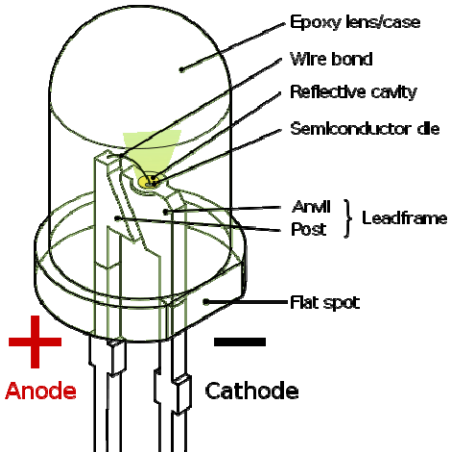
1. Outline of Glass bulb
2. Low pressure inert gas (argon, neon, nitrogen)
3. Tungsten filament
4. Contact wire (goes out of stem)
5. Contact wire (goes into stem)
6. Support wires
7. Stem (glass mount)
8. Contact wire (goes out of stem)
9. Cap (sleeve)
10. Insulation
11. Electrical contact

Activity 4 Cont'd: Additional Information Fluorescent Light Bulb Technology





Activity 4 Cont'd: Additional Information Light Emitting Diode Bulb Technology



Activity 5: Home Energy Awareness Survey

- **Homework or in the class**
  - **math calculations with a calculator or by long hand**
  - **A graph can also be made.**
  - **See Word file "Home_Energy_Awareness_Survey.doc"**

Name:_____

Home Energy Awareness Survey ("Given" kilowatts data from Benton PUD, June 2010)

	Column A	Column B	Column C	Column D
Appliance Type	Given: Kilowatts (1,000 watts)	Enter Hours Used per Day	Calculate Total Kilowatts Used (Col A x Col B = kW-hours)	Calculate Total Cost per Day* (Col C x $0.06)
Incandescent Lights 60W (or 0.06 kW)	.060	Example: 10	.06 x 10 = 0.6	0.6 x $0.06 kWh = $0.036 (3.6 cents)
Fluorescent Lights 18W	.018			
Television (42" LCD)	.210			

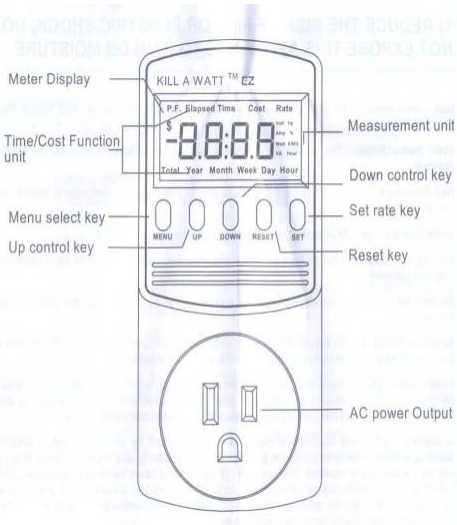
Incandescent bulb

Compact Fluorescent bulb

Activity 1 - Retake Survey

- **Return each student's pre-survey and state the answers to each question. Ask students to mark their sheet with the correct answer.**
- **Encourage discussion and plan for how they will improve energy conservation in their lives.**
- **Each student or group of students could prepare a poster explaining their plan for being more energy aware at home/school/community**
- **present it to the class Or…**
- **start a project such as a school wide energy audit/conservation**
  - **a recycling program**
  - **or a community awareness science project presentation.**

Appendix A: Kill-a-Watt Meter Instruction sheet



Quick Start Guide:

Use these quick start instructions to get up and running in just a few minutes. Be sure to review all the operating instructions later to ensure full enjoyment of the product.

1. Connect the Kill A Watt™ **EZ** unit to the outlet and the appliance to the unit
2. Press and hold the RESET key on the unit until "rESt" appears.
3. Press and hold the SET rate key until "Rate" is displayed and the currently set rate flashes.
4. Press the UP and DOWN key to set your desired rate. For example, if your utility charges you 10.6 cents per KWH, set the rate until the unit displays $0.106.
5. Press the SET key again. "SAVE" will appear briefly in the display.
6. To display the actual cost of power consumed or projected cost, press the MENU key until "Cost" is displayed in the LCD.
7. Pressing the UP and DOWN key will cycle through the cost projection periods. For example if the display indicates $2.34 and "Month", the unit is projecting that the attached appliance will consume $2.34 worth of electricity in one month.
8. To display the power measurements press the MENU key until "Volt" is displayed on the LCD.
9. To cycle through the various measurements press the UP and DOWN key as desired. The measurement unit currently selected will be indicated in the display.
10. To display the total consumed power in Kilowatt-Hours, press the MENU key until "KWH" is indicated in the display.
11. Review the complete operating instructions to familiarize yourself with all features.

Washington State
Science & Sustainability
Curriculum Standards
Related to Energy and Efficiency

Essential Academic Learning Requirements (EALR)

Science:
http://www.k12.wa.us/Science/Standards.aspx

State Standards – Sustainability

- Washington State Integrated Environmental and Sustainability Education Learning Standards, Standard 3 - Sustainability and Civic Responsibility:
  - Students develop and apply the knowledge, perspective, vision, skills, and habits of mind necessary to make personal and collective decisions and take actions that promote sustainability
- Battelle's lesson plan supports sustainability by increasing students' awareness of energy and energy efficiency.
  - Shows the effort and cost to make/use electricity.
  - Promotes thinking about turning things off, insulating (color choices), and buying energy efficient (more sustainable) products.

Resources

Battelle Resources – Grades 4-5

- Battelle's energy awareness lesson plans and supporting files: http://buildingefficiency-labworks.pnl.gov/education_k-12.stm
  - This PowerPoint file, including the Notes sections,
    - "Grade_4-5_Lesson_Plan_Current.ppt"
  - A PowerPoint file of just the key Activities slides for showing in the classroom to students.
    - "Grade_4-5_Lesson_Plan_Current_Classroom.ppt"
  - The pre and post Energy Survey, and Answer Sheet files:
    - "Pre-Post_Survey.doc" and in a pdf file also.
    - "Pre-Post_Survey_Answers.doc" and in a pdf file also.
  - The Home Energy Awareness Survey.
  - Kit inventory/purchase list for others' purchase of additional parts.
  - Teacher Feedback Form on the lesson plans
    - "Feedback_on_the_Energy_Awareness_Lesson_Plan.doc"
- Contacts
  - John Hail, 509-372-4799, John.Hail@pnl.gov, and
  - Theresa Koehler, 509-375-2415, Theresa.Koehler@pnl.gov

Many Resources Online ... Some:

- US Department of Energy, http://www.loseyourexcuse.gov
- Cool School Challenge (upper grades), http://www.coolschoolchallenge.org
- US Energy Information (EIA) Energy Kids, http://www.eia.doe.gov/kids
- Washington State OSPI grade level standards and resources, http://standards.ospi.k12.wa.us
- Arbor Scientific – lessons for grades 5-12 Student Lab Act. In Physics and Physical Science, http://www.arborsci.com/ArborLabs/ASLabs_Home.aspx
- The National Science Digital Library (NSDL) Literacy maps of the national standards, http://strandmaps.nsdl.org
- Beyond Penguins and Polar Bears – energy awareness, http://beyondpenguins.nsdl.org
- Science Net Links – Absolutely amazing site nearly limitless resources, http://sciencenetlinks.com
- Energy Quest – California, http://www.energyquest.ca.gov
- Classroom Energy K-12, http://www.classroom-energy.org
- National Energy Foundation for educators, http://www.nef1.org/educators.html

Resources, National Standards

(Thank you Kathy Fisk)

- Science Matters: Achieving Scientific Literacy, Hazen and Trefil.
- Science for All Americans, American Association for the Advancement of Science, Project 2061. Online viewing: http://www.project2061.org/publications/sfaa/online/sfaatoc.htm?txtRef=&txtURIOld=%2Ftools%2Fsfaaol%2Fsfaatoc.htm
- Benchmarks for Science Literacy, American Association for the Advancement of Science, Project 2061. Online viewing: http://www.project2061.org/publications/bsl/online/index.php
- National Science Education Standards, Center for Science, Mathematics, and Engineering Education. Some online viewing: http://www.nap.edu/openbook.php?record_id=4962
- Curriculum Topic Study, National Science Foundation. www.curriculumtopicstudy.org

Videos – Energy Basics

- **Bill Nye The Science Guy on Energy – kinetic energy, then electricity generation, (http://www.youtube.com/watch?v=0ASLLiuejAo&feature=related**
- **Potential Energy: Wile E Coyote & Roadrunner, http://www.youtube.com/watch?v=Jnj8mc04r9E&feature=related**
- **What is Energy? – Energy basics put to song, http://www.youtube.com/watch?v=o_5oYuDY2qM&feature=related**

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