Energy Module
Kaizen: Continuous Improvement

I. Introduction: Watt a Waste

Background: Energy is defined as the capacity to do work**.** It is found in many forms such as light, heat, wind, and electrical. All forms of energy fit into one of two categories: kinetic or potential. Kinetic energy is the energy of motion and potential energy is stored energy. The Law of Conservation of Energy states that energy cannot be created or destroyed but changed from one form to another. In any system as energy is changed from one form to another there is a loss of usable energy. The usable energy is referred to as energy efficiency.

One of the most commonly used forms of energy is electricity. Electricity is caused by the flow of electrons and is measured in units called watts. A watt is equal to current (in amperes-6.25 X 10^{18} electrons per second passing through a circuit) multiplied by voltage (measure of the strength of the electric current).

For more information on energy measurement and energy sources visit the following websites:

- www.NEED.org
- http://www.energyquest.ca.gov/time_machine/index.html
- http://www.eia.doe.gov/quiz/quiz.htm

Subject Area: Mathematics, Practical Living, Science

Kentucky Connections:

- Learner Goals: #1, #2, #5, #6

- Academic Expectations: 1.11, 2.1, 2.7, 2.8, 2.30, 5.1, 5.4, 6.1, 6.2, 6.3

- Core Content 4.1: MA-06-1.3.1, MA-06-1.5.2, MA-06-2.2.1, MA-07-1.3.1, MA-07-1.4.1, MA-07-2.2.1, MA-08-1.3.1, MA-08-1.4.1, MA-08-2.2.1, PL-06-3.1.02, PL-06-3.1.04, PL-07-3.1.02, PL-07-3.1.04, PL-08-3.1.02, PL-08-3.1.04, SC-07-4.6.2, WR-M-1.1.0, WR-06-1.1.3, WR-07-1.1.3, WR-08-1.1.3, WR-M-1.2.0, WR-06-1.2.3, WR-07-1.2.3, WR-08-1.2.3, WR-M-2.3.0, WR-06-2.3.3, WR-07-2.3.3, WR-08-2.3.3, WR-M-2.4.0, WR-06-2.4.3, WR-07-2.4.3, WR-08-2.4.3, WR-M-3.5.0, WR-06-3.5.3, WR-07-

3-5-3, WR-08-3.5.3, WR-M-3.6.0, WR-06-3.6.3, WR-07-3.6.3, WR-08-3.6.3

Materials:

- Package labels from a 60w soft white incandescent light bulb and a soft white energy saver compact fluorescent lightbulb (CFL) with equivalent wattage
- Calculator

Length of Lesson: One sixty minute class period

Vocabulary Words:

- CFL: Compact fluorescent lightbulb.
- Energy: Capacity to do work.
- Electricity: Flow of electrons from one point to another.
- Voltage: The rate at which energy is drawn from a source that produces a flow of electricity in a circuit.
- Volts: Unit used to measure electric potential at a given point.
- Amperes: Unit of electric current in the meter-kilogram-second system.
- Joules: Unit of work or energy, equal to the work done by a force of one Newton when its point of application moves through a distance of one meter in the direction of the force.
- Energy efficiency: Usable energy.
- Lumens: Light output.
- Watts: Equal to current (in amperes) multiplied by voltage (in volts).
- Kilowatt: A unit of power, equal to 1000 watts.
- Kilowatt-hour: Unit of electric energy equal to the work done by one kilowatt acting for one hour.
- Kinetic energy: Energy of motion.
- Potential energy: Stored energy.

Essential Question: What is the energy savings between soft white incandescent light bulbs and soft white energy saver compact fluorescent lightbulbs (CFL)?

Guiding Questions/Outcomes:

- Students will distinguish between the terms amps, volts, and watts.
- Students will develop criteria for making wise consumer choices concerning light bulbs.

Skills Used:

- Observing
- Comparing
- Organizing
- Planning
- Calculations

Activity:

- Using the information given on the label of each bulb complete the following table.

	Incandescent Lightbulb	CFL Lightbulb
Wattage		
Price		
Lumens (light output)		
Energy Used		
Life of bulb in hours		

- If the energy cost (EC) for the life (H) of a light bulb is calculated at a rate of $.10/kilowatt hour, what is the energy cost for each bulb in the experiment? The following formula may be used to convert first to kilowatt hours and then to energy cost.

  EC = (W x H/1000)*0.10

- How many incandescent bulbs would be needed to equal the life of a CFL?
- To calculate the energy cost for the number of bulbs in the previous question, multiply the total number of bulbs by the energy cost for each incandescent bulb.
- Subtract the energy cost of the CFL from the total energy cost of the incandescent bulbs. How much money would be saved by using a CFL?
- The purchase price of a CFL is greater than that of incandescent bulbs. To calculate the difference in purchase price subtract the initial cost of the incandescent bulbs from the cost of the CFL.
- To calculate total cost savings of using CFLs, subtract the difference in purchase price from the energy cost savings.

Assessment:

- Have each student design a newspaper ad emphasizing the advantages of using the lightbulb they found to be more efficient.

- Have each student count the number of incandescent lightbulbs in their home. Using the total cost savings calculated in this activity, have each student assess how much money their family could save by converting to CFLs.

Extensions:

- Have students log on to www.climatecrisis.net/takeaction/carboncalculator and calculate their environmental impact.
- Using the results from the previous activity, have students brainstorm ways to reduce their impact on the environment.
- Mercury is found in energy saver compact fluorescent light bulbs. www.lamprecycle.org provides information on the disposal of, or recycling of, fluorescent lights. Using information from this website, have students develop a recycling program for lightbulbs containing mercury.

Toyota Connection

- By installing fluorescent fixtures instead of using HID (High Intensity Discharge Lighting) TMMK saves 147 watts per fixture. TMMK has approximately 7000 fixtures in the plant. This saves enough energy to run 7900 36" color televisions.
- During breaks, lunches and in between shifts all of TMMK's process area lighting is shut off.
- Overhead lighting is wired to motion sensors and will shut off automatically when no movement is detected for 30 minutes.
- TMMK has installed motion sensors in all office areas so lights will turn off automatically and Team Members are turning off computers, printers, and copiers daily, to reduce electricity usage.

Old Style Lighting Fixture 368 Watts

New Style Lighting Fixture 221 Watts

III. Conclusion: Watt a Waste

Background: Vending machines run 24 hours a day and consume between 7-14 kilowatts of energy per day. This results in an average annual cost of $300 per machine. TMMK has approximately 375 vending machines and could be facing an annual cost in excess of $100,000. In an attempt to conserve energy, as well as cut costs, TMMK has turned off the lights in its vending machines. This saves 768 kilowatt hours of energy per machine every year. It saves $28 per machine per year for an annual total savings of $10,500. This annual energy savings would be enough to play, nonstop, a home video game system for 50 years.

For more information on vending machines and energy savings visit the following websites:

- www.energy.gov/state_energy_program/project_brief_detail.m/pb_id=865
- www.usatech.com/energy_management/energy_vm.php

Subject Area: Practical Living, Science, Writing

Kentucky Connections:

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Materials:

- Paper
- Pencil

- Calculator

Length of Lesson: 20 minute preparation time followed by one 60 minute class period.

Essential Question: How much energy could be saved in my school by turning off the lights in the vending machines?

Guiding Questions/Outcomes:

- Students will learn to read product labels on vending machines.
- Students will learn how to calculate daily and annual energy savings resulting from reducing wattage of light bulbs.

Skills Used:

- Observation
- Organization
- Comparing
- Calculating
- Communicating

Activity:

- Day 1:
  - Divide the students into pairs.
  - Assign each pair of students to a different area of the school to count the numbers and types of vending machines.
  - Observe the product label for kilowatts, energy efficiency, and annual operating cost.
  - Students should interview the school principal or bookkeeper to get the name of the distributors of the various vending machines.
  - Students should compile a list of the various distributors and divide the list equally between the pairs of students.
- Day 2:
  - Students should contact their assigned distributors about the number, expected life, and wattage of light bulbs used in the vending machines.
  - To calculate the amount of daily energy use for the lights in each vending machine, multiply the kilowatt hours / day by the number of light bulbs.
  - Remember that kwh/day = (Wattage/1000)*24
  - To calculate the total daily energy use for all vending machines in the building, multiply the kilowatt hours/day for one machine by the total number of machines.

- To determine the daily cost of running one vending machine, multiply the total kilowatt hours by the current cost of 1 kilowatt hour of electricity (national average of $.10/kwh as of January 2007). To find the cost of 1 kwh of electricity for Kentucky (or any state) visit the following website, http://tonto.eia.doe.gov/state/.
- How much energy could be conserved annually if the lights were turned off in every vending machine in your school?
- How much money could be saved?

Assessments:

- Prepare a report on energy conservation and cost savings of turning off the lights in the school's vending machines.
- Present the report to the SBDM council asking them to take action to conserve both energy and money.

Extensions:

- Conduct a survey of the vending machines in schools in your district. Calculate the amount of energy conservation and money saved for the district if the lights in every vending machine are turned off.
- Prepare a report for the school paper or for the local school board illustrating the benefits of turning off the lights in the vending machines.

Toyota Connection

- TMMK produces and uses approximately 20 billion cubic feet of compressed air per year. This takes much energy to produce. Recently TMMK purchased a new program for running air compressors that has increased efficiency by 26%. In the first year of use, enough energy was saved to heat and cool 1500 single family homes for one year.
- TMMK has lowered the pressure level on the compressed air system during non-productive periods.
- TMMK uses electric RAVs as shuttles.
- Heating and cooling systems go on and off during non-productive periods.
- Soft drink vending machines have motion sensors that turn them off and on when no motion is detected. This saves approximately $40.00 per machine per year. TMMK has approximately 200 machines.
- TMMK uses AGVs (Automated Guided Vehicles) to transport illuminated panels. AGVs run on small rechargeable DC batteries.

2007 Camry Hybrid

- Toyota's Hybrid Synergy Drive consists of gas and electric power sources that are complementary and produce a combined 187 horsepower.
- System varies between gas and electric, or both as needed.
- Camry Hybrid is equipped with an "ECO" button that limits energy consumption by the Heating/Ventilating/Air Conditioning (HVAC) system and under certain conditions can help improve fuel economy.
- Fuel efficiency rating of 40 mpg in the city, 38 mpg on the highway, and 39 mpg combined driving.
- Camry Hybrid is expected to be certified as an Advanced Technology Partial Zero Emissions Vehicle (AT-PZEV), one of a handful of cars to meet the strict AT-PZEV standard.

III. TMMK fieldtrip observations:

1. What model is TMMK's new energy efficient hybrid car? _____

2. What is the advantage to having lights that operate on motion sensors? _____

3. What type of vehicle does TMMK use as shuttles? _____
   Why? _____
   _____

4. What changes have been made on vending machines to save energy?
   _____

5. What is an energy treasure hunt? _____