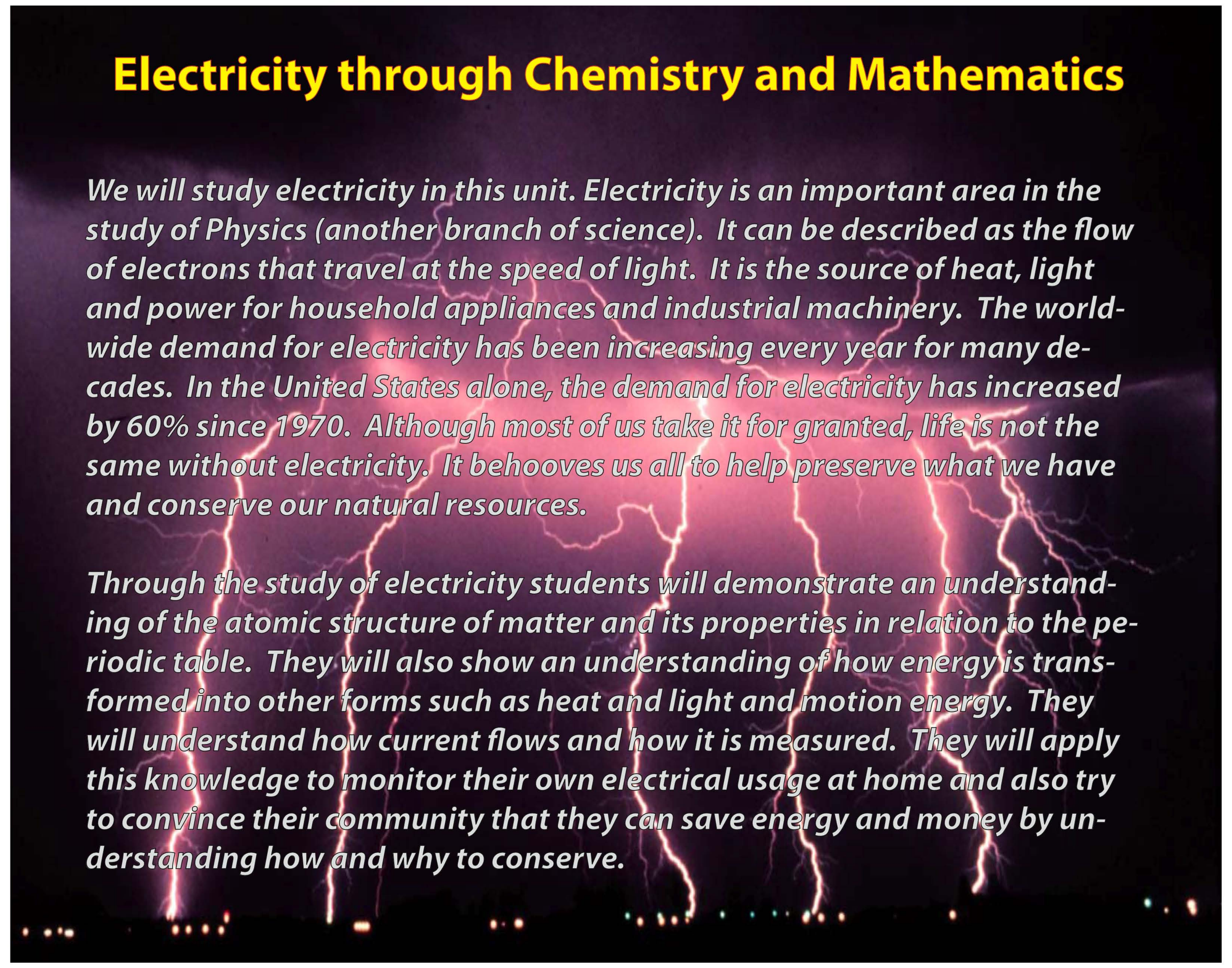


Lesson #1 (classroom meetings #1-2), Vijaya
Title: Atomic Structure
Description: Students will understand how the structure of the atom of an element will affect its charge carrying ability.
Goals: What is an atom made of? What are subatomic particles? How do atomic number and atomic mass relate to the number of electrons, protons and neutrons? How are electrons, protons and neutrons distributed within the atom of an element?
Estimated time: 2 meetings
Assessment activities: Build a model of an atom or perform a subatomic skit.

Lesson #2 (classroom meetings #3-4), Vijaya
Title: The Periodic Table
Description: Students will understand the arrangement of elements in the periodic table and how their position affects their properties.
Goals: Students will learn about the periodic law, analyze the difference between groups and periods, predict atomic mass of an element from the atomic number, explain vocabulary terms like atomic size, electro-negativity, ionization energy and ionic size, analyze periodic trends in the properties of elements in the periodic table.
Estimated Time: 2 meetings
Assessment activities: Jeopardy with vocabulary terms and "Who wants to be a chemist" using three lifelines.

Lesson #3 (classroom meetings #5-6), Vijaya
Title: Static and Current Electricity
Description: Types of electricity and their uses.
Goals: Students will understand that current flows by the movement of electrons in a domino like fashion and that like charges repel and unlike charges attract.
Estimated Time: 2 class meetings
Assessment activities: Activity sheets and Labs: electron train and experiments with balloons.

Lesson #4 (classroom meetings #7-9), Erik
Title: Fundamental units & dimensional analysis of electricity
Description: Electrical Voltage (potential difference), Current and Resistance.
Goals: Students will understand the physical definitions of electrical voltage, current and resistance. They will also work on their mathematical relationships, exploring various mathematical concepts such as composite numbers, exponential numbers of the tenth power (metric multipliers and their prefixes) or two linear equations with two variables.
Estimated Time: 3 class meetings
Assessment activities: Activity sheets, short homework paragraphs seeking for understanding, final exam.

Lesson #5 (classroom meetings #10-11), Vijaya
Title: Electrical Conductivity, Resistance, conductors and Insulators
Description: Current carrying substances and their properties.
Goals: Students will what makes atoms conduct electricity and why. They will test for conductors and insulators as well as resistance. In the process, they will also learn a set of vocabulary terms.
Estimated Time: 2 class meetings.
Assessment activities: Online and hands-on activities to test for conductors, insulators and resistance.

Lesson #6 (classroom meetings #12-13), Vijaya
Title: Transformation of energy
Description: Electricity can be used by transforming it into various forms.
Goals: Students will understand that, electricity can be produced from chemical reactions and used as the driving force in a battery.
Estimated Time: 2 class meetings.
Assessment activities: Making a battery

Lesson #7 (classroom meetings #14-15), Vijaya
Title: Heat, Light and Motion
Description: Electricity and its applications
Goals: How does resistance affect the flow of current? How can electricity be used? What happens if we don't have it?
Estimated Time: 2 class meetings.
Assessment activities: Online activities, activity sheets, skit, safety around electricity.

Lesson #8 (classroom meeting #16), Erik
Title: Electrical power
Description: Electrical Power as the fourth dimension besides Voltage, Current and Resistance
Goals: Students will understand the physical definition of electrical power and also how it is related to voltage and current (power as the product of the voltage and the current drop "P=VI"). No further exploration is done yet since the complete analysis takes place during the Ohm's law lesson. Also, students will continue working on the SI prefixes and metric multipliers during this lesson.
Estimated Time: 1 class meetings.
Assessment activities: Activity sheet, short homework paragraph seeking for understanding.

Lesson #9 (classroom meeting #17), Vijaya and Erik
Title: Guest speaker
Description: "How to read your electric meters."
Goals: Students will learn to read electric meters and use the information on their appliances to estimate the energy consumed by them.
Estimated Time: 1 class meeting
Assessment activities: As homework, students will complete an electricity and energy data sheet and be ready with the information needed to plot a graph in class at the next meeting.

Lesson #10 (classroom meetings #18-20), Erik
Title: Ohm's law
Description: All four variables of Electrical Voltage, Current, Resistance and Power (V, I, R, P respectively) being integrated into one mathematical relationship, i.e. an equation using three variables
Goals: Students will learn how to modify two independent formulas they have previously discovered (i.e. $V=IR$, $P=VI$) into universal mathematical relationships (such as $P=I^2R$), using non-linear equations of squares. They will be also introduced to proper use of calculators.
Estimated Time: 3 class meetings.
Assessment activities: Online activities, activity sheets, short homework paragraphs seeking for understanding, final exam.

Understandings:

* Why do only some elements conduct electricity and not others?
* How does electric current flow?
* How can current, voltage and resistance be measured?
* How can electricity become useful to us?
* How can the cost of electricity be calculated?
* How can electricity be conserved?

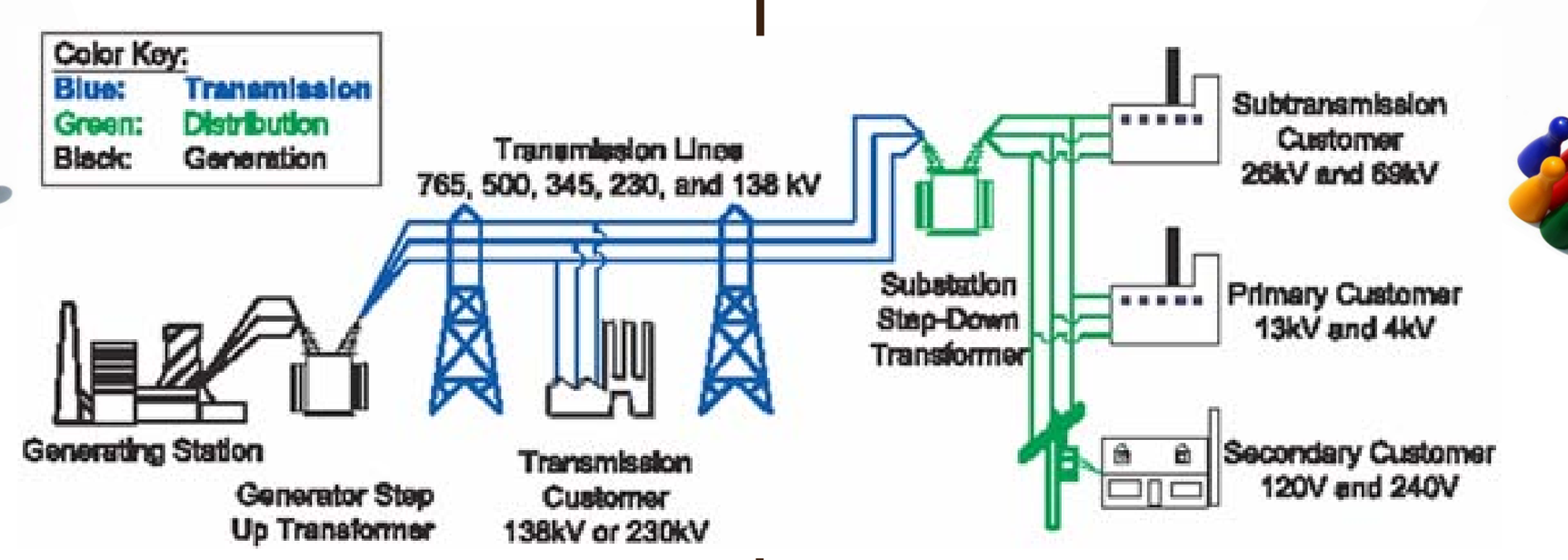
Skills - Students will be able to:

* from the mathematical point of the view:
  - multiply,
  - divide,
  - use fractions and composite numbers,
  - use cancelation rule, identify and solve basic exponential functions (with the base number 10) while naming metric multipliers,
  - solve linear equations with one variable and two unknown variables,
  - plot and read graphs and interpret bills
* Predict which substances are conductors/insulators.
* Design series and parallel circuits and learn how to stop and start the flow of current.
* Make informed decisions before buying batteries and bulbs for home or special projects.
* Be aware of electrical usage and find ways to save energy and money.
* Make conscious changes in habits or lifestyle to conserve energy.
* Know how to live without electricity for short periods of time.
* Monitor and track their usage over a period of time using software.
* Save energy and money by making changes in habits.

Lesson #11 (classroom meetings #21-22), Vijaya
Title: Making connections and simple circuits
Description: Elements of a circuit, types of circuits, design and representation of circuits.
Goals: What is a circuit? What are the elements of a circuit? Represent a circuit using symbols. Build a switch. Design a circuit to test for conductors and insulators. Build a simple circuit. Represent and build series and parallel circuits.
Estimated Time: 2 class meetings.
Assessment activities: Lab: Circuit design and building switches, representation of various types of circuits using electronic symbols for battery, circuit and resistors, designing series and parallel circuits, culminating task.

Lesson #12 (classroom meetings #23-24), Erik
Title: Batteries and EMF
Description: Batteries and Electromotive Force (EMF)
Goals: What exactly are they? And what do they do in the circuit? Do they have any physical significance on the circuit, i.e. changing its properties over the time? Then what exactly is internal resistance?
Estimated Time: 2 class meetings.
Assessment activities: Online activities, activity sheets

Lesson #13 (classroom meetings #25-28), Erik
Title: Mathematics behind Series & Parallel circuits, Reciprocals
Description: Calculating total resistance in Series & Parallel circuits
Goals: Students will learn how to generalize their understanding of the physical world into a few useful mathematical formulas using the idea of reciprocals. They will also intensively work on reading diagrams and calculating examples using calculators.
Estimated Time: 4 class meetings.
Assessment activities: Activity sheets, homework example of a complex circuit ("human circuit") to figure out its resistance, final exam.



Essential Vocabulary:

* electricity, electric current,
* atomic structure, flowing charge, energy conversion,
* batteries, generators,
* voltage, resistance, power,
* insulator, conductor,
* parallel circuits, series circuits,
* decalescent light bulbs, fluorescent light bulbs,
* energy usage costs

Knowledge - Students will know:

* There is a universality of electricity in the nature (even heart is an electric pump).
* Why some substances conduct electricity, while others do not.
* How current flows through a circuit.
* Definitions of unit specific vocabulary terms.
* Units of measurement for current, voltage and resistance, power and electrical energy.
* Electrical energy becomes useful when it is converted to other forms of energy such as heat, light and motion energy.
* Units in which electrical usage is measured and how the cost of usage is calculated.
* How to read electric meters and understand utility bills.
* How to use software to plot, analyze and interpret graphs.
* This unit is talking about a real world issue of energy resources.
* What they have at home is not granted (there is a lot in the background of switching a switch on and lightening the bulb).
* How to conserve a natural resource.

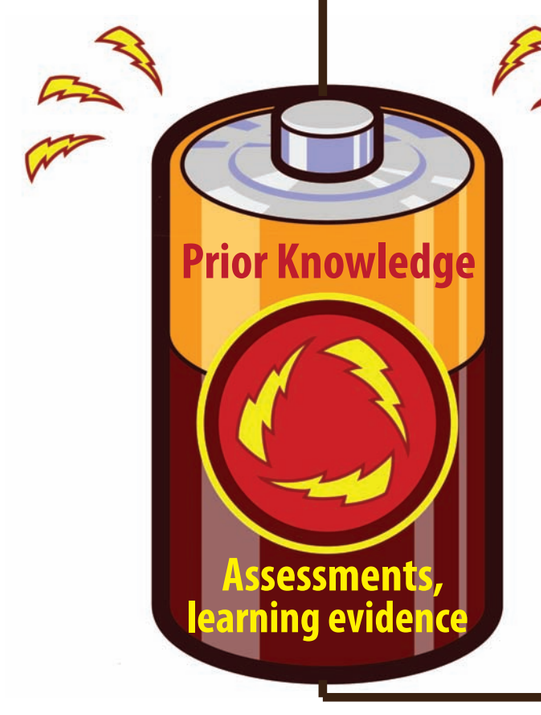
Essential questions:

* We can neither see nor touch electricity, so how do we know it exists? Where can we see effects of electricity? How would we describe them? What causes them?
* What do you know about electricity? And how could you describe/define it in your own words?
* How do you think the toaster works?
* If all atoms contain electrons, why is it that they don't all conduct electric current to the same extent? Are there factors that facilitate or hinder the flow of electrons? What makes a good conductor/insulator?
* What is needed for electric current to flow? How can the flow of electrons in a circuit be controlled? How are current, voltage and resistance related?
* Having considered the previous questions, how has your view for toasting a toaster changed?
* We all use electricity, but do we know how to read our electric meters and our monthly electric (utility) bills?
* How can we be efficient in our usage and promote conservation? The demand for electricity increases every year. In the United States alone, we use 60% more electricity than we did in 1970.1 It behooves us all to conserve our natural resources.

Lesson #14 (classroom meeting #29), Erik
Title: Cost-energy Savings Analysis of CFLs versus Incandescent Light Bulbs by Reading Electric Bills
Description: Reading Electric Bills, analyzing the data by plotting graphs, introducing other variables to the same graph and drawing out conclusions
Goals: Students will first learn how to read electrical bills and how to record the data in graphs using Excel. Then they will work with more variables on the same graph (e.g. average temperature, estimate number of CFLs), seeing direct and indirect changes of power usage and so exploring comparative cost-energy savings analysis of CFLs versus incandescent light bulbs. After this class, students will further explore CFLs and other possible measures to conserve energy.
Estimated Time: 1 class meeting.
Assessment activities: Excel worksheet, plotting and analysis of graphs, contribution to the class brainstorming as this class is a groupwork.

Lesson #15 (classroom meeting #30), Vijaya
Title: Structure and composition of CFLs and incandescent light bulbs and their role in conservation.
Description: Students will understand the structure and composition of CFLs versus incandescent light bulbs and their role in conserving energy. We will also discuss other measures of saving energy and costs of usage that will be further developed during the next lesson.
Goals: Students will learn that there are several ways to conserve energy at home as well as in the community.
Estimated Time: 1 class meeting.
Assessment activities: listening and asking questions.

Lesson #16 (classroom meeting #31), Vijaya and Erik
Title: Guest speaker
Description: Tips on conservation
Goals: Students will be exposed to various measures of conserving energy and resources and their part in it.
Estimated Time: 1 class meeting.
Assessment activities: As homework, students will write a letter to an elected official about the need and importance of conservation by suggesting three ways in which each of them would do it.



Lesson #18 (classroom meetings #34-35), Erik and Vijaya
Title: Conclusion of the unit.
Description: students draft their personal energy action plan and the persuasive essay.
Goals: Students will apply everything they have learned about electricity to draft a personal energy action plan and write a persuasive essay to convince their community to adopt one of the various measures for conserving energy. *Their work from the lesson #17 should be included as the graphs add on a general relevance of the paper by recalling specific data examples.*
Estimated time: 2 class meetings.
Assessment activities: Personal energy action plan and persuasive essay.

Lesson #17 (classroom meetings #32-33), Erik
Title: Conservation
Description: CFLs and other measures of conservation
Goals: This class is a direct continuation of previous classes. Students will analyze the energy -cost savings in electrical usage by using either CFLs or making changes in habits and lifestyle, individually applied to their own environment (house, apartment). They will draw back on what they learned about graphs as a group in the lesson #14, what they found out about conservation in the lesson #15, and what they have concluded after the discussion in the lesson #16.
Estimated Time: 2 class meetings.
Assessment activities: Electricity and energy data sheet, plotting and analysis of graphs.