STRATEGIC ENERGY INNOVATIONS

Grade: 9-12

Version 2

Aud. 2014

Home Energy Assessment

Evaluate home energy use and identify smart energy choices, learning about renewable energy, energy conservation, and energy efficiency

Table of Contents

This curriculum package includes:

- Two comprehensive lessons and the background information students need to know about energy efficiency, energy conservation, and climate change in order to take action to reduce their energy usage and impact on the environment
- Hands-on activities focused on completing a home energy assessment
- Practical applications in math and science to understand the economic and environmental benefits of energy efficiency and conservation

Academic Content Standards

California Science

Earth Science – Energy in the Earth System

4. Energy enters the Earth system primarily as solar radiation and eventually escapes as heat. As a basis for understanding this concept:

a. *Students know* the relative amount of incoming solar energy compared with Earth's internal energy and the energy used by society.

c. *Students know* the different atmospheric gases that absorb the Earth's thermal radiation and the mechanism and significance of the greenhouse effect.

6. Climate is the long-term average of a region's weather and depends on many factors. As a basis for understanding this concept:

a. Students know weather (in the short run) and climate (in the long run) involve the transfer of energy into and out of the atmosphere.

c. Students know how th Earth's climate has changed over time, corresponding to changes in Earth's geography, atmospheric composition, and other factors, such as solar radiation and plate movement.

d. Students know how computer models are used to predict the effects of the increase in greenhouse gases on climate for the planet as a whole and for specific regions.

Earth Science – Biogeochemical Cycles

7. Each element on Earth moves among reservoirs, which exist in the solid earth, in oceans, in the atmosphere, and within and among organisms as part of biogeochemical cycles. As a basis for understanding this concept:

a. *Students know* the carbon cycle of photosynthesis and respiration and the nitrogen cycle.

b. *Students know* the global carbon cycle: the different physical and chemical forms of carbon in the atmosphere, oceans, biomass, fossil fuels, and the movement of carbon among these reservoirs.

d. *Students know* the relative residence times and flow characteristics of carbon in and out of its different reservoirs.

Earth Science – Structure and Composition of the Atmosphere

8. Life has changed Earth's atmosphere, and changes in the atmosphere affect conditions for life. As a basis for understanding this concept:

b. Students know how the composition of the Earth's atmosphere has evolved over geologic time and know the effect of outgassing, the variations of carbon dioxide concentration, and the origin of atmospheric oxygen

Investigation and Experimentation:

1. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other four strands, student should develop their own questions and perform investigations. Students will:

d. Formulate explanations using logic and evidence.

m. Investigate a science-based societal issue by researching the literature, analyzing the data, and communicating the findings. Examples of issues include irradiation of food, cloning of animals by somatic cell nuclear transfers, choice of energy sources and land and water use decisions in California.

California's Common Core State Standards (CCSS) ELA Literacy

Language Standards: Vocabulary Acquisition and Use:

1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases based *on grades 9-10 reading and content*, choosing flexibly from a range of strategies. (9th or 10th grade)

4. Determine or clarify the meaning of unknown and multiple-meaning words and phrases based *on grades 11-12 reading and content*, choosing flexibly from a range of strategies. (11th or 12th grade)

6. Acquire and use accurately general academic domain-specific words and phrases, sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Speaking and Listening Standards: Presentation of Knowledge and Ideas:

1. Initiatve and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners *on grades 9-10 topics, texts and issues*, building on others' ideas and expressing their own clearly and persuasively. (9th or 10th grade)

1. Initiatve and participate effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners *on grades 11-12 topics, texts and issues*, building on others' ideas and expressing their own clearly and persuasively. (11th or 12th grade)

3. Evaluate a speaker's point of view, reasoning, and use of evidence and rhetoric, assessing the stance, premises, links among ideas, word choice, points of emphasis, and tone used.

4.a. Plan and deliver an informative/explanatory presentation that: presents evidence in support of a thesis, conveys information from primary and secondary sources coherently, uses domain specific vocabulary, and provides a conclusion that summarizes the main points. (9th or 10th grade)

4.b. Plan and present an argument that: supports a precise claim; provides a logical sequence for claims, counterclaims, and evidence; uses rhetorical devices to support assertions (e.g., analogy, appeal to logic through reasoning, appeal to emotion or ethical belief); uses varied syntax to link major sections of the presentation to create cohesion and clarity; and provides a concluding statement that supports the argument presented. (11th or 12th grade)

5. Make strategic use of digital media (e.g., textual, graphical, audio, visual and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest.

Reading Standards for Literacy in Science and Technical Subjects:

7. Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words. (9th or 10th grade)

7. Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem. (11th or 12th grade)

Writing Standards for Literacy in History/Social Studies, Science, and Technical Subjects:

1. Write arguments focused on *discipline-specific content*.
   a. Introduce precise, knowledgable claim(s), establish the significance of the claim(s), distinguish the claim(s) from alternate or opposing claims, and create an organization that logically sequences claim(s), counterclaims, reasons, and evidence.
   b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience's knowledge level, concerns, values, and possible biases.
   c. Use words, phrases, and clauses as well as varied syntax to link the major sections of text, create cohesion, and clarify the relationships between claim(s) and counterlcaims.
   d. Establish and maintain a formal style and objective tone while attending to the norms and conventions of the discipline in which they are writing.
   e. Provide a concluding statement or section that follows from and supports the argument presented.

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

6. Use technology, including the internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

7. Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

8. Gather relevant information from multiple authoritatize print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation including footnotes and endnotes.

California Technical Standards, Energy and Utilities Industry Sector

2.0 Communications 2.4 Listening and Speaking: 2.4 Deliver Multimedia Presentations:

2.4 a) Combine text, images, and sound by incorporating information from a wide range of media, including films, newspapers, magazines, CD-ROMs, online information, television, videos, and electronic media-generated images. (11th or 12th grade)

2.4 b) Select an appropriate medium for each element of the presentation. (11th or 12th grade)

2.4 c) Use the selected media skillfully, editing appropriately and monitoring for quality. (11th or 12th grade)

SAMPLE LESSON PAGE

Lesson 1.1 Ove

Estimated Time
Activity 1: 0.5 class periods (25 minutes)
Activity 2: 0.5 class period (20 minutes)

andards Covered
SS ELA Literacy:
guage Standards: 3, 6
ing Standards: 2.a-f, 4, 5
ng and Listening Standards: 4
l: Energy and Utilities Industry:
2.0 Communications: 2.2 (1.4), 2.3 (1.4)

Objectives: Students will
- Understand what a sustainability audit is and why performing one for a business is valuable
- Demonstrate professional communication skills th ll be us to directly communicate with business

Prep Time
- 2-3 hours

Handouts
- 3.1.1 Business Contact Information
- 3.1.2 Sample Recruitment Letter
- 3.1.3 Business Contact Log

Materials
- USB Thumb Drive, at least 2 G
- 1 Inch Binder to store worksheets and data
- Camera
- Calculator
- Ruler
- Eco Audit Program CD

Lesson 3.1: Introduction to Eco Audits and Recruiting a Business

sson, students will learn what exact ce Audit is and why they are bene businesses and students. They w basics of business recruitment and begin the recruitment process.

KEY WORDS

Audit: an inspection of an aspect of an organization. In this case, an audit inspects the sustainability practices in place in an organization with the intent of finding opportunities for improvement in sustainability that will help the organization save money

Carbon Footprint Analysis: a detailed examination of the amount of and source of carbon dioxide emitted to the environment by articular person or

lism: the competence or sk is a professional, which ed considerable time an tion

PREPARATION

In this module, students will work in small groups of 4-6 students to perform sustainability audits of local businesses. Each group will be in charge of recruiting a business to audit, and will complete an audit outside of school time. By the end of this module, students will have: recruited a business to receive an audit; performed an audit on that business; presented their findings to the business; and presented their findings and experiences to their peers

Because they will be working in the real w students will need some extra guidance and t as the module progresses. Students will need very careful records of everything they d extra care not to lose any of the work

Time needed for lesson

Summary of lesson purpose and outcomes

Standards covered in lesson

Time it takes to prepare lesson

Skills and knowledge outcomes

Important terms introduced in the lesson

Handouts included in lesson

Required materials

Instructions for preparing to teach the lesson

BACKGROUND FOR INSTRUCTORS

Sustainability

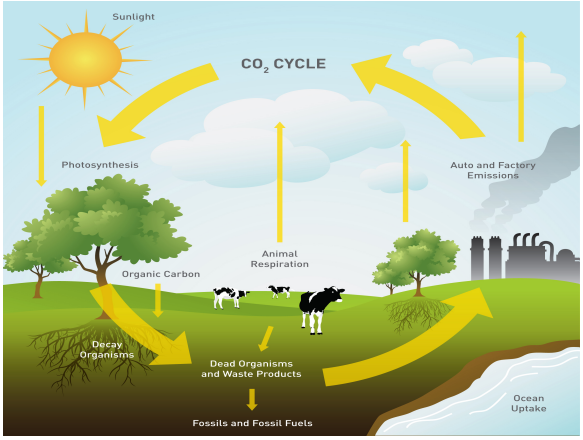
The root of the word sustainability is the ability to sustain or continue. Practices that are sustainable can be continued indefinitely at their present level. When we talk about sustainability in an environmental context, we mean protecting the Earth's ecological balance by not depleting natural resources at a rate that is faster than the rate at which natural resources can regenerate. For example, if we managed a forest which had 1,000 standing trees and 20 of those trees became mature for logging each year, the sustainable harvest rate would be 20 trees or less per year. We must also consider the total effects of our logging practices on the ecosystem, but with wise planning and choices the forest can continue to generate wood products indefinitely at this sustainable harvest rate. Achieving sustainability for our planet is much more complex than simply preserving economic yields; it involves balance within a complex system of interdependent relationships in the global network of life.

As consumers, we make choices that affect global sustainability. In order to be sustainable when we design new products and processes, we must consider the impacts on the triple bottom line – people, the planet, and profits (the economics of a decision). Our current economic system is linear. Materials move quickly from extraction to manufacturing to consumption and then disposal. The Earth's systems, however, are cyclical. Waste becomes food for other organisms. For example, trees in the forest will shed leaves and branches that provide nutrients for the both the tree and other organisms living on the forest floor. By moving materials quickly on this linear path from extraction to disposal, we are transforming our finite habitat (planet Earth) faster than the pace of adaptation. Humans, and other current species, have evolved over hundreds of thousands of years to the Earth's unique conditions. By changing those conditions faster than the pace of adaptation, we are threatening the ability of current species, including our own, to continue to thrive within our rapidly changing environment.

Climate Change

The Carbon Cycle and Fossil Fuels

An example of how humans are changing the environment to which we have adapted is the effect we have had on global climate. Our reliance on unsustainable fuel sources has caused an imbalance in the carbon cycle and led to global climate change. Fossil fuels, such as coal, oil, and natural gas were formed when decaying plant and animal matter buried deep underground were subjected to unique conditions, including intense heat and pressure for millions of years. When we dig up these fuel sources and burn them for energy, carbon dioxide is released into the atmosphere. Because we are burning fossil fuels at a MUCH faster rate than they can be formed, we are not only running out of these fuel sources but we have created an overabundance of carbon dioxide in the atmosphere.



[1]

The Greenhouse Effect

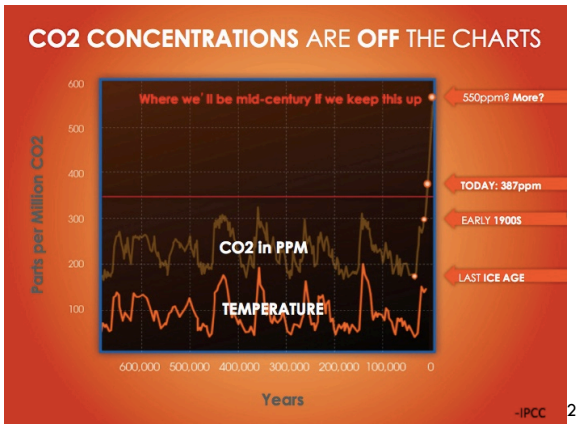
Carbon dioxide, along with methane and nitrous oxide, are the most prevalent greenhouse gases (GHGs) on Earth. When solar radiation passes through the atmosphere and warms Earth's surface, the warm Earth re-emits infrared radiation. Some of this radiation is naturally trapped in the atmosphere by GHGs. Therefore, the more GHGs we have in the atmosphere, the more infrared heat is trapped, raising the

[1] Carbon cycle image courtesy of Dave Murro

overall surface temperature of the Earth, like a blanket. If there were no greenhouse gases in the atmosphere, the Earth's surface would be too cold to survive, so having some greenhouse effect is crucial to life. Unfortunately, by releasing GHGs into the atmosphere at an unprecedented rate, we are creating many environmental problems.

Carbon Dioxide in the Atmosphere

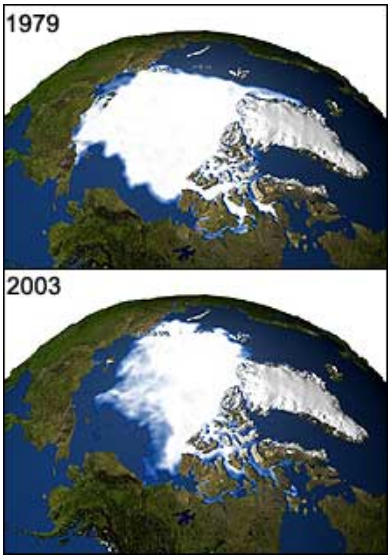
The human contribution to the greenhouse effect is largely due to the burning of fossil fuels, but agricultural practices, deforestation, waste, and many other societal systems also add to the total human-sourced carbon dioxide that is accumulating in our atmosphere. The Intergovernmental Panel on Climate Change (IPCC) has measured levels of carbon dioxide on Earth over hundreds of thousands of years and discovered that over the last 200 years CO_2 levels have increased from an average of 275 parts per million (ppm) to over 400ppm in 2013.



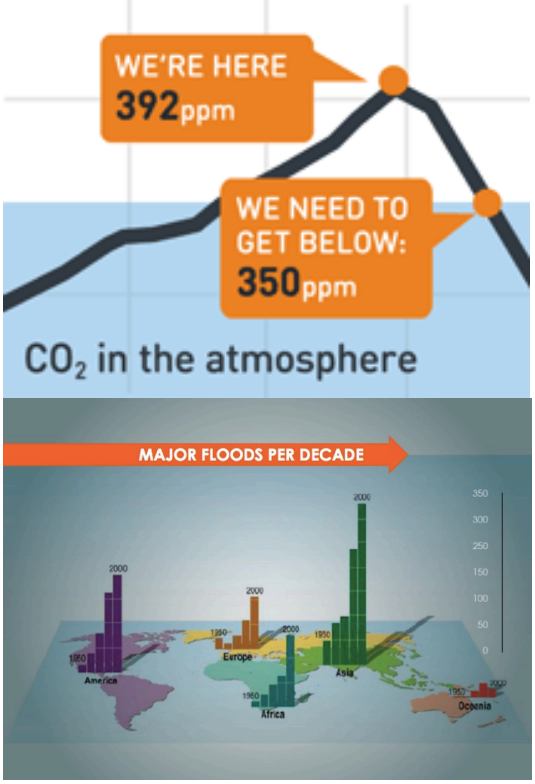
[2]

Consequences of Climate Change

The large increase in atmospheric carbon dioxide and other greenhouse gases over the last 200 years has triggered an increase in average global temperatures that leads to many impacts. With climate change we expect to see and have already seen: extreme events such as floods, droughts, storms, and fires; intense heat waves; shifting weather patterns that threaten food and water supplies; changing disease patterns such as malaria in expanded areas of the world; shrinking ice sheets; and rising sea levels, displacing coastal communities around the world.



Scientists at the IPCC have identified the highest safe level of carbon dioxide in the atmosphere to be 350ppm. If we do not reduce our carbon dioxide emissions, we risk reaching a tipping point in global temperature that could threaten the ability of current species on Earth, including humans, to adapt to rapidly changing conditions.



[2] All images from 350.org from IPCC data

What is Energy?

Energy is the ability to do work—everything needs energy to function. We use energy for power, electricity, and heat in many aspects of our daily lives: to cook food, drive cars, manufacture products, and construct buildings, just to name a few.

Energy comes from two different types of sources, non-renewable and renewable. A **renewable energy source** is one that can be replaced at the same pace or faster than it is used, while a **non-renewable energy source** can only be replaced over a *very* long period of time or cannot be replaced at all. Our reliance on non-renewable fuel sources has contributed to global climate change.

Non-Renewable Energy Sources

The most common non-renewable energy sources used worldwide are fossil fuels like oil, coal, and natural gas. **Fossil fuels** were created over millions of years as heat and pressure transformed the remains of decayed plants and animals buried underneath layers of sediment. Fossil fuels store carbon and emit carbon dioxide when burned. Burning fossil fuels also emits other pollutants like particulate matter, nitrogen dioxide, and sulfur dioxide.

Renewable Energy Sources

Renewable energy harnesses power from natural resources, like sunlight and wind, which are plentifully supplied by nature. The most common forms of renewable energy are solar, wind, hydropower, geothermal, and biomass. Renewable energy sources do not generally emit greenhouse gas emissions directly.

Energy Use in the US and California

The United States is largely dependent on oil, coal, and natural gas for its energy, which are significant contributors to global climate change. We use fossil fuels mostly for transportation fuel and electricity.

Resource Type	US	CA	GHG Emissions Level
Coal	42%	8.2%	High
Large Hydro	8%	13%	Low
Natural Gas	25%	35.6%	Medium
Nuclear	19%	15.3%	Low
Petroleum	<1%	0	High
Other	0	13.8%	
Renewables	5%	14.2%	Low

Table 1. Electricity Resource Mix for 2011[3]

As shown in Table 1, the United States as a whole relies mostly on coal for electricity generation, since it is widely available in most parts of the US. California uses mostly natural gas for electricity. Some of this natural gas is extracted from within the state, but most is imported from nearby states like Colorado and Arizona.

Historically, fossil fuels have cost much less to use than renewable energy, and are therefore used much more widely. However, concern over our reliance on fossil fuels is growing worldwide. Fossil fuels emit greenhouse gases, are becoming more expensive and complicated to extract, and involve numerous environmental, political, and social risks. New interest in renewable energy is blooming as the technology and cost of renewable energy improve.

California has made it a priority to use clean energy sources and invest in renewable energy. As a result, renewable energy is used much more in California, as compared to the rest of the United States. The last column in Table 1 provides an overview of the level of greenhouse gas emissions associated with each energy source.

[3] Sources: California Energy Commission, http://energyalmanac.ca.gov/electricity/total_system_power.html U.S. Energy Information Administration: http://www.eia.gov/energy_in_brief/article/renewable_electricity.cfm