To Grid or Not to Grid: Developing an understanding of sustainable living in the 21st century

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This curriculum unit is recommended for:
Career and Technology Education, Grades 6 – 8
Integrated Science, Grade 8

Keywords: green architecture, sustainable living, The Lorax, off-the-grid, natural resources, conservation

Teaching Standards: See Appendix 1 for teaching standards addressed in this unit.

Synopsis: With the population of the world steadily increasing, energy consumption levels are also increasing across the globe. Human beings have the ability to help conserve the nonrenewable resources that naturally exist in this world by relying more on renewable energy sources such as sunlight and hydropower. In order for people to have a direct impact on the environment, they must make thoughtful efforts based on a developed knowledge and understanding of the implications of both depleting non-renewable resources and harnessing energy from renewable resources.

This instructional unit will be taught during the 2014-2015 academic year to 125 students in grades six through 8 in an elective course entitled Green Architecture - a Career and Technical Education available through Project Lead the Way.

To Grid or Not to Grid:
Developing an Understanding of Sustainable Living in the 21st Century

NaToya Dingle

Content Objectives

In the ever-evolving society of today, it is critical that students have a knowledge and understanding of how energy affects the progression of growth of areas near to them as well as locations across the world. Students should know that "energy is everywhere. Anything we eat or use has energy embodied in it. Every object we produce required energy to make and/or energy to transport and the energy demands are closely linked to the economic growth of a country."[1] Energy is an important part of the design process for a large quantity of devices and products that we use often to satisfy the various wants and needs of human life. Additionally, sources of energy are important to our economy and national security.

For this unit, students will have the ability to explore various energy sources that are commonly used to power homes and other establishments across the United States. Specifically, students will focus on North Carolina, Georgia, and South Carolina for their investigations as these are neighboring states that are near Coulwood Middle School. With this in mind, students will be able to make direct connections to these states because of familiarity due to proximity and similarity of weather patterns and geography. Additionally, students will delve into the emerging field of sustainable architecture which is also known as green building design.

"The field of sustainable architecture has grown since the advent of the U.S. Green Building Council's Leadership in Energy and Environmental Design certification program in 1998…[with a] focus on topics such as preventing environmental degradation and mitigating environmental effects of construction."[2] In their efforts to help conserve energy by decreasing their carbon footprint and reliance on fossil fuels, an estimated 1.7 billion people[3] in the world live "off the grid" which means to function and operate in a home environment that has eliminated the necessity of utilities such as electricity, water, and natural gas. Throughout this unit, students will explore what it means to live off the grid and make educated decisions about energy usage in their area and the United States. They will also make informed decisions about how or if a lifestyle such as this could have an impact on Earth's available natural resources.

This unit has been designed to introduce students to sustainability and careers that are available to them through Science, Technology, Engineering, and Math (STEM)

careers such as architecture or mechanical/civic engineering. The goal is to create an interest in the environment and its care while allowing students to build new skills in technology by conducting research and creating their own homes via programs that are used by professional architects. By the end of the unit, students will be able to explain how energy is harnessed and the implications of its procurement and usage. Students will also use the knowledge that they have acquired throughout the unit to make educated decisions about the design of a home that could be considered green and, therefore, less harmful to the environment.

Target Audience

Coulwood STEM Academy is a partial magnet, Title I, middle school. This means that the school has a specific number of seats allocated for students that have chosen to attend this school to benefit from a rigorous academic track that is based on concepts in science, technology, engineering, and mathematics (STEM). Additionally, Coulwood STEM Academy receives additional federal funding in efforts to work to close the achievement gap that exists among its high number of economically disadvantaged students.

There are approximately 660 students that are currently enrolled. Of this number, 78 are a part of the partial STEM magnet program. The sixth through eighth grade student population ranges in age from 10 to 15 years old. Currently, 81 percent of students at Coulwood STEM Academy are recognized as economically disadvantaged through their application and acceptance to free and/or reduced-lunch programs[11]. Of these students, approximately 70 percent of these students are identified as African-American or Black. Of the remaining 30 percent, approximately 13 percent are identified as Caucasian and 12 percent are Hispanic. The remaining five percent are Asian, American-Indian, or other race. According to the school progress report[12], roughly 51 percent of the students are male whereas 49% are female.

Approximately 75 sixth, seventh, and eighth grade students will participate in this course. Courses are gender-based which allows female students the opportunity to willingly participate in projects and activities that they normally would not pursue due to fear of embarrassment or ridicule from their male peers. While students are exploring the same content, gender-based groupings allows the teacher an invaluable opportunity to diversify the lesson delivery to accommodate the learning styles and patterns of male students versus female students. The anticipated work products, course rigor, and behavior expectations remain consistent among the two genders.

This curriculum is intended for students in grades six through eight and can be taught in alignment with an Integrated Science curriculum or other course that delves into energy concepts. With a large focus on career explorations and technology use, this unit can also be taught as a part of a Career and Technical Education course. Due to the nature of this unit, educators can easily modify lessons to align with grade level

competencies. The culminating activity is intended for students of all academic achievement levels as individual student work expectations can be modified as the students' individual educational plans require.

Background Knowledge

Every living thing on Earth uses energy that is derived from resources that are provided by the environment. Through interactions with each other and their physical environment, organisms produce, acquire, or decompose biomass and related carbon-based compounds. By performing these functions, they provide materials to human beings in the form of food and building materials. This also contributes to the regulation of soil, air, and water quality. As the human population continues to rapidly increase, it is possible that if not responsibly utilized, the quality and availability of resources on this earth could diminish.

The environment in which we live is affected in many ways by our need and acquisition of energy. Obtaining some energy sources has a much greater impact on our environment than others. This leads to the integration of renewable and nonrenewable resources when harnessing energy which is known as alternative energy. Alternative energy is energy that has been produced from sources other than the typical energy suppliers: fossil fuel, natural gas, oil, and coal. Companies that harness energy have become more aware of the importance of environmental protection and many are working with various governmental agencies to reduce its long-term impact.

Coal, oil, and natural gas are three types of fossil fuels that humans have heavily depended on for various needs such as public mass transportation, electricity, and gas for vehicles. These resources are considered non-renewable due to their limited supply availability and or inability to naturally reproduce over a shorter period of time. Nonrenewable resources are often favored for usage as they are less expensive to use when converting from one type of energy to another. At the current rate of consumption, these fuels cannot replenish themselves fast enough to meet the current and future energy demands. Currently, fossil fuels and nuclear energy are the supplier of 93 percent of the world's energy which means that alternative energy sources such as wind and water are only responsible for seven percent of the world's energy needs.

According to the United States Department of Energy, the total world energy demand is for about 400 quadrillion British Thermal Units (BTU) each year. A BTU is roughly equal to the energy and heat generated by a match. Oil, coal and natural gas supply approximately 88 percent of the energy needs for the world. Oil provides the largest percent of the supply of energy worldwide. It supplies approximately 41 percent of the world's energy supply which is roughly 164 BTU. Coal provides 24 percent of the world's energy which is roughly 96 quadrillion BTUs, and natural gas provides the remaining 22 percent which is approximately 88 quadrillion BTUs.

Nuclear energy, which is generated by the splitting of atoms, accounts for six percent of the supply of energy currently used worldwide. It is highly unlikely to become a major source of energy because of the dangers that are associated with the splitting of atoms. Additionally, although they are relatively inexpensive to run, nuclear power plants are not inexpensive to build. For example, according to a Union of Concerned Scientists report, between 2002 and 2008 cost estimates for nuclear power plant construction rose from approximately four billion dollars to an average nine billion dollars per unit. A few governments such as that of the United States see the potential that lies in the use of nuclear energy and are pushing for the further exploration of its use in the near future. Other agencies, on the other hand, are still pushing for the usage of alternative energy sources.

Renewable or alternative resources are sources that are natural such as sunlight, water, and wind. These resources can be repeatedly generated and are seemingly infinitely available. Additionally, renewable resources have little to no carbon dioxide emissions and are, therefore, considered to be green and environmentally friendly sources of energy. In order to entice people to move towards using renewable energy sources, various tax incentives, waivers, and deductions are available for individuals and businesses that make a conscious effort to "go green." While alternative energy sources seem to be the ideal route in order to sustain our world, there are also a few other issues to consider such as cost. Initial construction costs of plants are quite steep and in some cases, damage can be done to existing ecosystems when creating wind farms and dams to harness hydro and wind power.

"Some estimates say our fossil fuel reserves will be depleted within 50 years, while others say it will be 100-120 years. The fact is that neither one of these projections is very appealing for a global community that is so heavily dependent on fossil fuels to meet basic human needs."[7] According to Jim Baird[8], it is believed that the current fossil fuel reserves could last us for the following number of years:

Coal – 417 years
Oil – 43 years
Natural gas – 167 years

If these projections were accurate, based on current population trends and consumer usage, oil reserves would be depleted by 2050. It has been forecasted that, for the oil industry alone, it would take eight trillion dollars over the next 25 years to maintain current oil production levels. With this in mind, many energy production companies are investing in renewable energy sources.

"The challenges facing the energy industry are growing more difficult every day. Projects are increasing in size, complexity, risks and costs. At the same time, society is transforming and demanding more from both business and government. These changes

create challenges and opportunities for companies in the energy industry, policymakers, and society at large."[9] Governing bodies and their constituents "will inevitably disagree over the greatest energy challenge facing the country. Some will point to security matters, others to economic problems, and still others to climate change and the environment."[10] For this unit, students will explore the various energy resources that are available and how conservation efforts will or will not impact our environment.

Teaching Strategies

This unit will be broken down into approximately 20 days of student learning and practice. It is intended to be delivered as a project-based inquiry unit in order to encourage critical thinking as the students begin to delve into the concepts with the instructor serving as a facilitator. With this in mind, the teacher will allow the students many opportunities to think and collaborate with their classmates with extremely limited lecture/talk time at the front of the classroom. The teacher will initiate conversation topics throughout the lesson in efforts to get students to research information and to present informed answers to the classroom during open class discussions. These questions will vary according to the age and ability levels of each student group. Some of the questions will be as follows:

- Will Earth run out of resources for energy? Why or why not?
- How do you know if a resource is renewable or not?
- What are some negative consequences of harnessing energy through renewable resources? In the long run, is it worth it?
- Which alternative energy source would be best suited for North Carolina? Support your answer with relevant information.

In order to successfully complete the final activity, students will need to have access to Autodesk Revit architectural design software. It is suggest that students become familiar with this software before this unit is taught in order to allow all focus to be placed on understanding the concepts connected to energy and sustainability.

By the end of the unit, students will be able to explain how photovoltaic cells transfer solar energy into electrical energy. While they will not be required to create a photovoltaic cell for this unit as written, this could be a hands-on activity that could easily be added while students are learning about the various types of energy resources. Students will also be able to articulate the importance of citizens to become less dependent on nonrenewable resources. Students should be encouraged to delve into these topics on their own while the teacher facilitates so that the instructor can be available to students as necessary. This entire unit is built for collaboration as this teaches students how to interact and convey their thoughts while learning new information.

Classroom Activities

The following plans outline what students are expected to accomplish throughout the unit. Students will be required to create work samples each day that are aligned to the essential question. Each lesson is designed to be connect information from the previous day by delving deeper into the meaning of the key vocabulary terms for the unit. Following the structured lectures and course activities, students will be required to investigate green architecture. They will have online access to Rebuilding Greensburg to use as a reference for various architectural techniques. While students are not required to memorize various techniques and skills of green architecture, they must be familiar with energy conservation and techniques that are used in order to complete their end project.

While students are not regularly tested in this particular course, it is suggested that checks for understanding are done frequently to ensure that students are grasping the information quickly. The majority of the themes of this unit are a part of every science curriculum from elementary to high school level. The pace of the unit has been established on the premise that the content being taught will serve as more of a review than new content. A major portion of class time should be, however, dedicated to key vocabulary as these are terms that students will have to be familiar with for standardized testing purposes.

Lesson 1: Introduction to Sustainability and the Environment

Estimated time for completion: approximately one day

Essential Question: What can you do to make the environment better for your children and grandchildren?

What do students need to learn to be able to answer the Essential Question?

People need to be aware of resource depletion and environmental degradation that results from area development.

Career opportunities that are related to sustainability are on the rise. Specifically, the demand for architects and engineers that are able to meet societal needs and wants while preserving our natural environment is on the rise.

Some architectural firms are now focusing on "building green" to reduce the impact on human health and our natural environment.

Knowledge and Skills

Categorize concepts related to building eco-friendly establishments

Identify examples of STEM careers and explain the increasing demand of these professionals in our society

Key vocabulary to preview/ graphic organizer

Air quality
Architect
Architecture
Biomass
Carbon footprint
Carbon monoxide
Conservation
Ecosystem
Environment
Fossil fuel
Geothermal energy
Greenhouse effect
Hydroelectric power
LEED
Nonrenewable resource
Recycling
Renewable resource
Solar power
Sustainable

Instruction

Students are introduced to the new unit through an abbreviated lecture from the teacher. This miniature lecture is to provide a lesson overview so that students are aware of what they are expected to learn for this unit. Students will be briefly introduced to concepts, key terms, and the essential questions for the unit.

Students will watch the video Green Goes Home Build it Better: Rebuilding Greensburg. While watching the video, students should record words that they hear throughout that they believe to be directly related to green architecture and /or the environment. At the conclusion of the video, students will pick two words that they are most interested in learning more about. They will research the terms and, using their own words, define what their chosen words mean. Students will then present their findings to the entire class.

Checks for understanding

Student Concept Map – complete with essential questions and vocabulary terms

Following the vocabulary activity, students will participate in a class-wide discussion about ideas and misconceptions they have about the terms that they just reviewed.

The teacher will guide the discussion.

> What does "green" mean to you after completing this activity?
>
> Describe a misconception you had about one of the green vocabulary terms. Where do you think this misconception originated?
>
> As your classmates described their words, what were two words that you did not know the meaning of prior to this activity?

Assignments/Assessments

Using the Discovery Education Techbook for North Carolina science, students will be required to define the remaining key vocabulary terms that were not discussed during the group activity. Students will have several options for recording their definitions in order to appeal to each students' learning style:

> Option 1 – Using the Frayer Model, define each of the key vocabulary terms for this unit. You are not required to color your drawings, but may do so if you would like. If you do not finish in class, finish the definitions for homework before the next class.
>
> Option 2 – Create a Prezi to define each vocabulary term for this unit. You MAY include videos and sounds to help you remember each word. If you do not finish in class, this assignment should be completed as homework before the next class.
>
> Option 3 – Create a Glog that highlights each vocabulary term. Be sure to include all terms from this unit. If you do not finish your Glog in class, this assignment should be completed as homework before the next class.
>
> Option 4 – Create a song, poem, rap, or short story to help you remember each key vocabulary term for this unit. If you do not finish your Glog in class, this assignment should be completed as homework before the next class.

Summarizing Strategies

Seven minutes before the class ends, students will stop working and transition to end-of-class journal time in which they will respond to the following prompt:

What can you do to make the environment better for your children and grandchildren?

Lesson 2: The Recycling Process

Estimated time for completion: approximately three days

Essential question: What is the importance of recycling?

What students need to learn to be able to answer the essential question:

People need to be aware of resource depletion and environmental degradation that results from area development.

The recycling process is very complex.

Recycling helps sustain the environment for future generations.

New jobs in the recycling industry and manufacturing are created across the United States as the amount of materials submitted to be recycled increases.

Activating Strategies

Students will watch the following videos about recycling during the first six minutes of class. After each video, they will be given time to record their thoughts and ideas in their STEM notebook.

http://youtu.be/Zh4F3sZNLqA → The Cycle - 3 Minute Version
http://youtu.be/Il1RX6_h9Xc → Peppa Pig Recycles

Key vocabulary to preview/add to graphic organizer

Air quality
Conservation
Ecosystem
Environment
Recycling
Sustainable

Teaching strategies/instruction

Students will be given 5 minutes to read Why Recycle?[13] independently and silently at their seats.

The teacher will guide students through a short lecture with the aid of Microsoft PowerPoint software on the process of recycling. Students will follow along and take notes as necessary.

Checks for understanding

Students will answer the following questions on the corresponding Google Classroom document entitled "Why Recycle? Do Now"

1. What happens to recyclables?
2. Why is land-filling not a sustainable planning approach?
3. How does recycling prevent pollution?
4. How does recycling create jobs?
5. How does recycling save energy?

Independently or in pairs, students will create a Prezi, PowerPoint or Glog to create a stimulating advertisement or presentation that explains the importance of recycling and encourages people to recycle. Students must be sure to include some of the negative aspects of recycling as well in order to receive full credit.

Assignments/assessments

Students will use their advertisements that they are creating as a platform for research on the importance of recycling and working to preserve our environment for future generations. Students will present their work and attempt to help their classmates understand how recycling can positively affect the environment that they live in. Students' research should also reveal the trade-off that occurs from recycling such as high costs and unsanitary recycling plants.

Using Autodesk Inventor Professional 3D design software, design and create an updated three dimensional model of the recycling symbol. You MAY use inspiration from the current design, but you should not repeat the same design. Think of the audience that you are creating for and make it relevant to other teenagers across the country.

Summarizing strategies

Seven minutes before the class ends, students will stop working and transition to end-of-class journal time in which they will respond to the following prompt:

What is the importance of recycling?

Lesson 3: Sources of Energy/Renewable vs. Nonrenewable Resources

Estimated completion time: approximately two days

Essential question: Why is it important for us to conserve energy and consider alternative energy sources?

What do students need to learn to be able to answer the essential question?

What are the sources of energy that are currently available in the United States?
Which sources are renewable?
Which sources are nonrenewable?
At the rate of which energy resources are being consumed today, is there a possibility of us running out? If so, when will run out?
What are the pros and cons associated with the usage of each energy source?
Which alternative energy sources, if any, are best suited for use in Charlotte, North Carolina?

Activating strategies

1. The class will begin with students watching the short video "Energy, Let's Save it". Before the video begins, students will be encouraged to think of all the ways that they use energy in their daily lives.
   http://youtu.be/1-g73ty9v04
2. At the conclusion of the video, students will turn and talk to their table partner that is seated on their right/left for two minutes about the ways that they use energy in their daily lives. At the end of the two minutes, the entire class will come back together to share some of the ways that they use energy daily.
3. Following this brief discussion, the students will turn and talk to their table partner across from them and brainstorm different ways to conserve energy and why conservation is important.

Key vocabulary to preview/add to graphic organizer

Biomass
Conservation
Energy
Fossil fuel
Geothermal energy
Hydro power
Natural gas
Nonrenewable energy resources
Nuclear energy (uranium)
Oil (coal)

Renewable energy resource
Solar energy
Wind energy

Teaching strategies/instruction

The teacher will guide students through a short lecture with the aid of Microsoft PowerPoint software. The lecture will be on the progression of energy resources that have been used in the United States from the early 16th century to present day. While the teacher is giving information, the students will record notes on the guided notes handout that the teacher will provide to each student.

To review the various available energy resources, students will complete the online web quest available to them through their Google Classroom account. Students will be required to explore energy resources and information about energy usage in the United States and across the world. This will be an independent assignment, but students may consult with their table partners for research ideas and web sources.

As a review from the previous lesson on recycling and a miniature lecture on the importance of conservation, students will watch "Recycling and Energy Conservation: Kids' Version". → http://youtu.be/v0V-3E64ht0

Checks for understanding

In pairs, students will look at the notes that they created during lecture time. Students will use this information to assess why they believe the use of various sources of energy have changed over time. Together, students will create a thoughtful paragraph that answers the following question: What events in history may have had an effect on energy consumption in the United States?

Students will be encouraged to think of information that they have studied in their social studies courses. Also, students should think of ideas such as population growth and technological advancements. Students will be able to use technology to research answers as needed. Once students have finished answering their thought-provoking question, pairs will share their answers with their classmates and compare their ideas.

Energy Web Quest

Directions: Answer each question using complete sentences. Be sure to answer each question completely and include the web addresses to the sites that you used for our class resource list. ** Remember, Wikipedia does not count as a valid source of information for this class!! **

1. Visit www.energy4me.org. Using the information from this site as a foundation, in your own words explain what energy is.

2. How is energy harnessed from the sun?
3. Is wind energy a good option for Charlotte, NC? Why or why not? Be sure to support your answer with facts.
4. Has water ever been a major source of energy? Support your answer with facts from your research.
5. What factors have to be considered when trying to decide which energy source is the best for a particular area?
6. In your opinion, which energy source would be best for New Orleans, LA? Which source would be best for Capetown, South Africa? Be sure to base your answer off of factual information that you have found in your research.
7. According to World Energy Organization, what country is number one in nuclear power production? Which country is second?
8. How much oil power does Saudi Arabia produce per year?
9. What are the pros and cons of nuclear power as a major source of energy?
10. According to National Geographic, what is expected to happen to water demand for energy by the year 2035?
11. Using computer software, create two pie charts that compare energy resources that were commonly used in 1750 to energy resources that are commonly used today. Be sure to list where you retrieved your data from.

Students will choose one of the articles below and complete an article analysis. Printed copies of the articles will be available for students to use, but they may also use the online versions as well.

Energy Conservation
http://ngm.nationalgeographic.com/2009/03/energy-conservation/miller-text.html

Energy Conservation
http://www.energy4me.org/energy-facts/energy-conservation/

Assignments/assessments

Students will complete the energy IQ quiz via Energy Kids.
http://www.eia.gov/kids/energy.cfm?page=quiz

Students will research where they would like to live 10 years from now. They must complete the following activity independently:

1. The year is 2025. Think of where you would like to be living 10 years from now. You can choose any area that is currently inhabited by human beings.

2. Investigate which resources the area that you wish to live in is currently using. What are the top 2 energy resources that are most commonly used in the area?
3. Are these resources environmentally conscious for the long-term existence of the area? If not, what alternative energy resources could be used instead? Be sure to consider important facts such as the amount of cloudy versus sunny day the area has.
4. Assuming that the cost of living for various utilities and expenses has not increased, would it be more cost-effective to add your alternative resources or would it cost more money in the long run? Be sure to support your answer with valid research.
5. In a short essay (at least three paragraphs), compare and contrast the energy resources, costs, and environmental impact of the used resources of where you currently live and where you wish to live in the future.

Summarizing strategies

Seven minutes before the class ends, students will stop working and transition to end-of-class journal in which they will respond to the following prompt:

Why is it important for us to conserve energy and consider alternative energy sources?

Appendix 1: Implementing Teaching Standards

<table>
<tr><td colspan="2">UNIT: Energy & Sustainability</td></tr>
<tr><td>Grade/Subject:</td><td>6th – 8th Grade PLTW Green Architecture Elective/8th Grade Integrated Science</td></tr>
<tr><td>Length of Unit:
A/B Day Schedule</td><td>For this unit, students' culminating project will be on Autodesk Revit. The length of the unit depends on students' prior of this program and how to use it. For this particular set of students, a prior background knowledge of the program and its features has already been established.
6th Grade – 4 weeks
7th Grade – 3 weeks
8th Grade – 3 weeks</td></tr>
<tr><td colspan="2"><u>UNIT GOAL</u>:
Explain the environmental implications associated with the various methods of obtaining, managing and using energy resources (North Carolina Essential Standard 8.P.2)

<u>North Carolina Essential Standard 8.P.2.1</u>
Explain the environmental consequences of the various methods of obtaining, transforming, and distributing energy.

<u>North Carolina Essential Standard 8.P.2.2</u>
Explain the implications of the depletion of renewable and nonrenewable energy resources and the importance of conservation.</td></tr>
<tr><td>Prioritized Standards Based Knowledge & Skills</td><td>• Renewable resources are natural resources that can be replaced or reused
• Nonrenewable resources cannot be replaced in nature
• Renewable resources are replaced through natural processes at a rate equal to or greater than the rate at which they are used
• Air, freshwater, soil, living things and sunlight are renewable resources
• Sunlight (solar energy) is a renewable resource because it will continue to be available for billions of years (it is a source of energy for all processes on Earth)
• Nonrenewable resources are exhaustible because they are being used at a much higher rate than the rate at which they are formed (coal, oil, natural gas, diamonds, metals, other minerals)
• Fossil fuels exist in a fixed amount and can only be replaced by processes that take millions of years
• Living resources can contribute to environmental changes in land, air and water if removed without being replaced or replanted
• Humans can prevent or slow the depletion of resources by reducing, reusing or recycling
• Conservation involves preventing the loss of a resource by way of thoughtful management of it</td></tr>
</table>

Notes

1. The University of Waikato. "Why is energy important?" *Science Learning*. http://www.sciencelearn.org.nz/Contexts/Future-Fuels/Sci-Media/Video/Why-is-energy-important
2. "Sustainable Architecture Schools: How to Choose." *Education Portal*. http://education-portal.com/articles/Sustainable_Architecture_Schools_How_to_Choose.html
3. Wood, Jennie. "*Living Off the Grid: What does it mean to really live off the grid?"* infoplease. http://www.infoplease.com/science/environment/off-the-grid.html
4. United Nations Environment Programme. *Ecosystem Services.* http://www.unep.org/maweb/documents/document.300.aspx.pdf
5. Union of Concerned Scientists. "Cheap dream, expensive realities." http://www.ucsusa.org/our-work/nuclear-power/cost-nuclear-power#.VFo6eldLN2A
6. US Department of Energy. Office of Energy Efficiency and Renewable Energy. "Government Energy Management." http://www.energy.gov/eere/government-energy-management
7. McLamb, Eric. Ecology Global Network. *Fossil Fuels vs. Renewable Energy Resources.* http://www.ecology.com/2011/09/06/fossil-fuels-renewable-energy-resources/
8. Baird, Jim. The Energy Collective. *"*Eternal Energy Production*".* http://theenergycollective.com/jim-baird/236986/eternal-energy-production
9. World Economic Forum. *"*Energy*".* http://www.weforum.org/issues/energy
10. Council on Foreign Relations. *The U.S. Energy Challenge*. http://www.cfr.org/energy-policy/us-energy-challenge/p25485
11. Great Schools. *Coulwood Middle*. http://www.greatschools.org/north-carolina/charlotte/1230-Coulwood-Middle/details/#Extracurriculars
12. Goldberg, Rachel. "School Progress Report 2010-2011." *Coulwood Middle School*.https://owl.english.purdue.edu/media/pdf/20110928111055_949.Pdf
13. Eco cycle. "Why Recycle?" http://www.ecocycle.org/files/pdfs/why_recycle_%20brochure.pdf

Suggested Student Resources

California Energy Commission. *Energy Story*. http://www.energyquest.ca.gov/story/chapter19.html

Discovery Education. *Techbook*. http://www.discoveryeducation.com//what-we-offer/techbook-digital-textbooks/index.cfm

Eco cycle. "Why Recycle?" http://www.ecocycle.org/files/pdfs/why_recycle_%20brochure.pdf

EcoMall. *20 Things You Can Do to Conserve Energy.* http://www.ecomall.com/greenshopping/20things.htm

Energy4me. "Energy Conservation". *Energy Facts.* http://www.energy4me.org/energy-facts/energy-conservation/

National Geographic. *Energy Conservation.* http://ngm.nationalgeographic.com/2009/03/energy-conservation/miller-text.html

Scholastic Inc. "Fossil Fuels". *Study Jams.* http://studyjams.scholastic.com/studyjams/jams/science/energy-light-sound/fossil-fuels.htm

Scholastic Inc. "Natural Resources". *Study Jams.* http://studyjams.scholastic.com/studyjams/jams/science/energy-light-sound/natural-resources.htm

Scholastic Inc. "Renewable Fuels". *Study Jams.* http://studyjams.scholastic.com/studyjams/jams/science/energy-light-sound/renewable-fuels.htm

The Guardian. "What's energy efficiency and how much can it help cut emissions?" *Environment.* http://www.theguardian.com/environment/2012/jun/08/energy-efficiency-carbon-savings

U.S. Energy Information Administration. *Energy Kids*. http://www.eia.gov/kids/

Suggested Teacher Resources

British Columbia. "What is Air Quality". *BC Air Quality*. www.bcairquality.ca/101/what-is-air-quality.html

Conserve Energy Future. "Advantages and Disadvantages of Recycling." *Recycling.* http://www.conserve-energy-future.com/advantages-and-disadvantages-of-recycling.php

Duke Energy. “Save Energy & Money”. *North Carolina*. http://www.duke-energy.com/north-carolina/savings.asp?segment=res&prmState=nc&prmZip=28262

Envision Charlotte. *2013 Annual Report*. http://www.envisioncharlotte.com/annual-report/

National Geographic Online. “Water Demand for Energy to Double by 2035”. *News*. http://news.nationalgeographic.com/news/energy/2013/01/130130- water-demand-for-energy-to-double-by-2035/

Open Data Center Alliance. “Carbon Footprint and Energy Efficiency Rev 2.0”. *Open Data Center Alliance Usage Model.* http://www.opendatacenteralliance.org/docs/Carbon_Footprint_and_Energy_Efficiency_Rev2.0.pdf

The National Action Plan for Energy Efficiency. *Energy Efficiency as a Low Cost Resource for Achieving Carbon Emissions Reductions*. http://www.epa.gov/cleanenergy/documents/suca/ee_and_carbon.pdf