The Brightside of Energy Consumption

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This curriculum unit is recommended for:
8th Grade Integrated Science

Keywords: renewable, nonrenewable, energy, conservation, STEAM, environmental justice, fossil fuels, oil, coal, natural gas, solar, biomass, hydropower, wind energy, geothermal, advocacy

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

Synopsis: In this unit, students will learn how to become advocates for themselves and their communities while learning about the various types of energy that we use to power our society. In the process, students will learn about the consequences of energy production as well as the implications that this has on their everyday lives, especially as students from a low income, Title I school. This unit will also focus on incorporating STEAM (Science, Technology, Engineering, Art, and Math) education into an 8th grade science classroom to inspire students to think critically about solutions to the energy and environmental crises that are occurring in the United States and around the world. Students will be encouraged to focus on cleaner, alternative energy sources, such as solar energy and other sources derived from light.

I plan to teach this unit during the coming year to 140 students in 8th Grade Integrated Science.

Introduction

School/Student Demographic

Martin Luther King, Jr. Middle School, located in the Hidden Valley neighborhood of Charlotte, has a population of students that is currently 42.5% African American, 51% Hispanic, and 6% other ethnicities. We have approximately 1,050 students in grades 6-8. Our diverse population of students includes 18% percent of students that receive ESL services (English as a Second Language) and 8% of students that receive EC services (Exceptional Children). In addition, Martin Luther King Jr. Middle School because of the number of high-poverty families it supports qualifies as a Title I School under the Elementary and Secondary Education Act (ESEA). School-wide programs are in schools that have at least a 75% poverty level, based on the number of students designated as economically disadvantaged.

I am currently teaching Integrated Science for 8th graders (ages 13-15) at MLK Middle School. Eighth grade science is a course that concludes with an End of Grade assessment, or an EOG, which is administered by the state of North Carolina. In Integrated Science, students begin to delve into subjects such as chemistry, hydrology, energy, ecology, biotechnology, pathology, and evolution. Classes occur in 90 minute blocks and students attend science on an A-Day, B-Day schedule. I have 140 students in 6 blocks, with class sizes ranging from 25 students to 27 students. Integrated Science includes students of all levels and abilities, including English Language Learners and Exceptional Children, without distinction between classes. For this reason, students enter with different levels of prior knowledge, they learn at different paces, and they require different styles of teaching and learning. Last year the 8th grade science department achieved 70% proficiency (a score of 3, 4, or 5) on the EOG, indicating that only a little over half of our students are college or career ready in science. Every day, I also teach a 40-minute academic enrichment block. There are less students in this class (around 12) and it is considered an intervention or an extension of science. I am able to choose my students for this class and I usually target students who can be pushed to the next level of their learning with a little additional attention and practice.

Rationale

In contemporary society, one of the most politically charged environmental issues is energy; more specifically balancing the energy needs of a growing population with protecting natural resources and lands. The United Nations Department of Economic and Social Affairs projects that the world population will reach 9.7 billion people by 2050.[1] As the population skyrockets towards 10 billion people, energy consumption will also increase at an unsustainable rate. If this issue is not addressed, the world will be faced with environmental, social, and economic consequences that when combined result in a bleak future.

Despite the urgency of this issue, last year the 8th grade science learning community at Martin Luther King Jr. Middle School found that one of the hardest units to plan for was the energy unit. In our data, we saw that students were not mastering the content. Furthermore, as teachers, we found it difficult to create innovative ways to present the material. Overall, it was one of our least successful units. As a teacher with an Environmental Science background, I found this very unfortunate, especially considering the relevance of this topic. The consequences

of energy development and use, as apparent in our rapidly changing climate, demand an immediate need to be addressed and discussed. I believe that if I can help my students create a connection with the content, they will be able to master it as well.

My solution is to create a unit where students can step into professional and stakeholder roles to address issues that are affecting their lives in real time. Within this unit, students will become masters of the content and then will be able to apply their knowledge to real-world situations. They will gain experience with the concept of environmental justice, a social movement that originated not far from where my students attend school. Allowing them to explore the implications of what they are learning will encourage them to connect with the content in a way they previously could not. Through this experience, students will develop leadership and advocacy skills as they learn of new possible career paths in the field. Our seminar leader, Professor Tom Schmedake, conveyed that "There is a lot of money in saving the world!" With this greater purpose in mind, my students will be motivated to think outside the box about clean energy innovation.

There were many events that inspired me to create this unit. Over the summer, I worked for the Sierra Club, an environmental nonprofit, and got to partake in the implementation of the Ready for 100 Campaign, in which cities around the country pledge to convert to 100% renewable energy resources within a certain timeframe. One of the biggest issues that we faced was the realization that low income and minority communities did not have the same access to clean energy solutions, even though they were more likely to be faced with the consequences of burning fossil fuels (such as poor air quality, heat waves, and vulnerable infrastructure in worsening climatic conditions). This disparity is a huge barrier to equitable energy production, and I immediately saw the connection between this and the community that I teach in, Hidden Valley. It became especially relevant as I considered recent events, such as the Duke Coal Ash Spill that primarily affected the water supply of low income and minority communities. Through my seminars with the Chemistry and Art of Light, I have been able to solidify my understanding of how powerful light can be as an energy source. We have explored various ways that energy can be harnessed from a light source such as the sun. I believe that with the correct knowledge and tools, my students can learn how to make solar energy more affordable and accessible to all communities, including their own, and that they can learn how to communicate with officials who design and implement energy policies that directly affect them.

Unit Objectives

According to North Carolina Essential Standards, students must be able to identify types of energy that the United States relies on, as well as their pros and cons. They must be able to distinguish between renewable and nonrenewable sources of energy. Students must be able to determine what energy is used for, as well as how it is obtained, developed, and distributed. They should be able to understand the path that energy takes to be able to power our homes. Students will explore the consequences of energy usage and as a result the importance of conservation. In this unit, my students will explore the current energy usage in the United States and in North Carolina. They will also research alternative sources of energy including solar, wind, and hydropower. They will consider the advantages and disadvantages of each source to select the best source for our energy needs.

I would like to use this unit to develop leadership and advocacy skills among my students. They will be placed in roles, such as politician, lobbyist, and city designer, where they must use their knowledge to think critically to develop system-wide solutions. In addition, they will be required to work in teams for various activities. The end project for most students will be a structured debate, or a town hall, where groups will be able to argue for their type of energy or for their stakeholders. Our English Language Learners, as well as our other students, will benefit greatly from this group work. I would like my students to be able to recognize issues surrounding Environmental Justice in their communities and how to use the correct tools to amend them.

Beyond these objectives, my vision is to include aspects of STEAM (Science, Technology, Engineering, Art, and Math) into this unit that will combine aspects of the various 8th grade curriculums to emphasize the importance of all subjects in school and to highlight how these different topics can converge. According to the US Department of Education, the total number of STEAM related jobs in the USA will increase by 14% over the course of this decade (2010-2020), yet most students are unprepared to fill these roles. STEAM education, introduced at an earlier age, can allow scholars to develop critical thinking and problem solving skills.[2] The addition of art into the program enables children to work on hands-on projects. Finally, because our students have a variety of strengths that they bring to the classroom, each scholar will find at least one activity they can connect to.

Content

From this unit, I have developed three Learning Essential Questions (LEQs) to guide student inquiry. LEQ 1 and LEQ 2 focus on gathering background information while LEQ 3 focuses more on application.

LEQ 1: How is electricity created using various energy resources?

LEQ 2: What are the resources that North Carolina and the United States rely on for energy? What are the advantages and disadvantages of each type of energy?

LEQ 3: You are proposing a plan to the CEO of Duke Energy for the future of energy in North Carolina. Considering availability, environmental impacts, and North Carolina's new goal to use more renewable resources, come up with a plan to convince the CEO that your industry's energy source is the best for North Carolina.

Pacing

Science at Martin Luther King, Jr, Middle School is attended on an A-Day B-Day schedule. This unit should take about two weeks (ten days) or 5 blocks (90 minutes each). A supplemental project will take place in Pride Time, a 40 minute academic enrichment block that occurs daily to further knowledge and provide additional support. In Pride Time, the project should take about 3 weeks (15 class periods).

Key Vocabulary

2nd Tier Words: Conservation, Depletion, Consequence, Implication, Alternative, Transfer, Advocate, Convert

3rd Tier Words: Energy, Renewable, Nonrenewable, Solar, Coal, Petroleum, Hydroelectric, Wind, Nuclear, Biomass, Geothermal, Fossil Fuel, Greenhouse Gas

Light as Energy

In our "Art and Chemistry of Light" seminars, we centered several nights on light as energy. The light from the sun provides the earth with more than enough energy to meet our needs, yet the majority of it is not utilized. Solar, or photovoltaic cells, are able to take the immense energy from the sun and convert it into electricity. In the Photovoltaic effect, light energy in the form of photons is converted into electricity in the form of voltage. Light is absorbed by a material and then electrons are released as a result. Traditional solar cells are created from silicon, second generation cells are crated to be more flexible with thin layers of semiconductor materials, and third generation cells are created with innovative solar dyes, printing and plastics.[3] The material is treated with an electric field, positive on one side and negative on the other. When electrical conductors are attached to each of the sides to form a circuit, the electrons that are released can be captured in the form of a current to create electricity. The electricity generated from a number of cells can be harnessed together and transferred through metal plates to wires to power our homes and other buildings. The amount of energy produced varies, depending on factors such as temperature and hours of sunlight.

Energy Production in the United States

According to the U.S. Energy Information Administration, the United States has relied on nonrenewable fossil fuels such as coal, oil, and natural gas for more than 80% on their energy requirements since 1900. Burning fossil fuels results in a myriad of environmental consequences including the release of greenhouse gases such as methane and carbon dioxide. As carbon levels in the atmosphere increase, the greenhouse effect intensifies. The greenhouse effect is a natural process that heats the surface of the Earth as light from the sun is either reflected back into space or absorbed by greenhouse gasses. The escalation of greenhouse gas levels by human activity, however, is causing the average temperature of the Earth to increase.[4] This is only expected to worsen as the population of the planet, and therefore its energy needs, skyrockets. In addition to these harmful effects, fossil fuels are limited and will run out shortly if we continue to consume them at an unsustainable rate.[5] Alternative sources of energy, especially those that derive from light energy, offer a clean and sustainable solution. Light from the sun provides the Earth with enough energy to meet our needs, however in the United States less than 2% of solar energy is used.

North Carolina does not have any coal, oil, or natural gas production but relies primarily on nonrenewable resources such as fossil fuels and nuclear energy to power the state's industries and homes. In fact, our state has one of the highest rates of nuclear energy production in the country. Over 19 million acres of woodland cover North Carolina, and provide biomass energy production and employment for more than 70,000 people that work in the state's forestry products industry. Rivers provide hydroelectric power to many communities and offshore winds along the coast could provide substantial energy as well. However, in North Carolina only one-tsenth of all energy comes from renewable resources. On the bright side, solar energy capacity has increased greatly in the state throughout the past decade, providing the state with about 4% of their energy needs.[6]

Energy Sources

Renewable-Renewable energy is an energy source that is easily replenished or that will not run out in the near future. Solar energy, biomass, hydroelectricity, wind, and geothermal are all examples of renewable energy. Most of the renewable energy sources rely on light from the sun in one form or another. In general, renewable sources of energy are considered to be more environmentally friendly, because with the exception of biomass, they are almost carbon neutral. On the other hand, they are not accessible in all areas of the country and the technology used to harness it is more expensive.

Solar-Solar energy is a renewable source of energy that is derived from sunlight. It is the ultimate source of all energy and life on Earth. Photovoltaic cells, or solar cells, absorb light energy and release electrons to create electricity. Solar energy systems have less of an environmental impact than fossil fuels and do not release pollutants such as carbon dioxide. On the other hand, solar energy relies on many variables: such as time of day, location, season, and weather. Additionally, a large amount of surface area or land is required to harness adequate amounts of energy.

Biomass-Biomass is a renewable energy source that contains organic material from plants and animals. Light energy is stored within these living (or once living) things in the form of chemical energy. Garbage, wood, waste from wood processing, crops, and alcohol fuels are all considered biomass. Biomass can be burned directly for energy, or can be converted into alternatives such as biogas and biofuels. Biomass may result in negative environmental consequences such as deforestation, which can in turn lead to erosion. Furthermore, burning biomass releases greenhouse gasses into the atmosphere.[7]

Hydroelectricity-Hydroelectricity is a renewable energy source derived from running water in streams and rivers. It is one of the oldest-used sources energy and is also the largest producer of renewable energy in the United States. Hydropower is generated when running water in the form of mechanical energy causes a turbine to turn, generating electricity. Hydropower is driven by the water cycle, which is in turn powered by solar energy. Although the water cycle will ensure that hydropower will always be available, there are several downfalls. Hydroelectric dams must be constructed on rivers to generate energy, which limits the geographic location that this technology can be used. These dams can cause ecosystem damage, such as freshwater habitat loss, flooding, and the interruption of migration patterns. Water that is released from dams is often much hotter and contains much less dissolved oxygen than the water commonly found in freshwater ecosystems, which is detrimental to aquatic life. In addition, electricity production can be interrupted seasonally and by drought conditions.[8]

Wind-Wind is created by the unequal heating of the Earth's atmosphere by the sun. Wind is used to turn wind turbines to create electricity. When determining the location for wind power plants, or wind farms, engineers must consider the amount of wind the area receives as well as the speed of the wind. Wind increases with altitude, so ideal locations for wind turbines include tops of smooth, rounded hills; open plains and water; and mountain gaps that funnel and intensify wind. There is also potential for wind energy offshore of the country. Wind energy, although clean and unlimited, is unpredictable and visually affects landscapes as well as birds and bats.[9]

Geothermal-Geothermal energy originates from heat within the center of the Earth. Breaks in the Earth's tectonic plates allows this heat to escape to the surface in the form of steam or hot water, which can be used to generate electricity.

Nonrenewable-Nonrenewable energy sources are limited resources that cannot be easily replenished. Fossil fuels, such as coal, oil, and natural gas, take millions of years of heat and pressure to form. Nuclear energy is derived from uranium, which is a limited and unstable material. Nonrenewable energy resources are unsustainable and temporary solutions to our energy needs, and often times result in dire environmental consequences.

Fossil Fuels (Coal, Oil, and Natural Gas) –Fossil fuels have earned their name because they are derived from the remains of plants that lived millions of years ago in swampy conditions. After being buried underneath layer upon layer of dirt, heat and pressure over millions of years converts the chemical energy in the remains to coal, oil, and natural gas. Because of the extensive period of time needed to create fossil fuels, they are considered nonrenewable. The extraction and burning of fossil fuels has been detrimental to the environment. Beginning during the industrial revolution, the burning of these substances has caused the amount of greenhouse gasses in the atmosphere to spike, resulting in the warming of our planet as well as subsequent consequences. Despite these implications, coal is one of the primary energy sources used in the United States. This solid fossil fuel contains high levels of hydrocarbons. To extract it from the ground, techniques such as strip mining and mountain top removal have been invented. In the process, the ecosystems surrounding these areas have been destroyed. Gasoline is the most common petroleum product that is consumed in the United States. As society has seen in recent decades, oil can be a conflict-inducing substance. In addition, oil spills have wreaked environmental havoc on aquatic ecosystems. Natural gas, the last fossil fuel, releases the lowest level of greenhouse gasses and is considered the "cleanest". However, it presents transportation challenges, as we have seen recently with protests surrounding natural gas pipelines. Finally, the methods used to search for and obtain natural gas, such as fracking, have negative consequences like earthquakes and water pollution.

Nuclear- Within the nucleus of an atom, there are two subatomic particles that are bonded together. There is a tremendous amount of energy found within these bonds that can be released upon the splitting of the atom. This process is known as nuclear fission, and is the source of nuclear energy. Uranium, a limited and radioactive element, is the most commonly used atom in this process. Nuclear energy is one of the most controversial sources of energy, due to the high risk associated with its production. Although it is capable of producing a large amount of clean energy (carbon-free), an uncontrolled nuclear reaction could create serious contamination of air and water resources by radioactive waste.[10]

Environmental Justice

Environmental justice is the movement surrounding the inequitable idea that low income communities and communities of color bear more of an environmental burden than their counterparts. These communities are more likely to be exposed to toxins, poor air quality, and poor water quality. The environmental justice movement began in Warren, North Carolina (not too far from Charlotte) in 1982 when construction plans for a hazardous waste landfill in a primarily African-American community were protested by over 500 citizens. As a result, studies

were conducted to examine the correlation between race and the burden of environmental hazards. Studies concluded that race was the most significant factor in siting hazardous waste facilities, and that three out of every five African Americans and Hispanics live in a community housing toxic waste sites.[11] Today, more than 35 years later, the movement is still strong. Our society still experiences these injustices, as we have seen in recent situations such as the contamination of the Flint River and the Duke Coal Ash Spill, both of which primarily affected low income communities.

Instructional Implementation

Teaching Strategies

Turn and Talk

This quick and informal teaching strategy allows students to engage in academic discussion. Answering questions in class does not often offer the opportunity for discussion; either students are not answering questions or the same students are being called on to provide the "right" answer. Turn and talk allows a differentiated method of student interaction where scholars get the chance to verbalize their thoughts and solidify their learning. In addition, they are also hearing the content again but from their peers and in other words.

Close Read

A close read is a deep, thoughtful analysis of a text that focuses on the text itself. In this case, the text is a graph. The selection is often a short passage, as a successful close read requires many reads. Students do not need to have background knowledge about a text to perform this task. This process allows students to acquire a deeper level of background knowledge and to search for patterns within the text.

Gradual Release

The gradual release method, also considered a method of scaffolding, or "I do, We do, You do", moves the classroom instruction from teacher centered to student centered. At the beginning of the lesson, the role of the teacher is to deliver the content through direct instruction, think aloud, and modeling. The goal of the student is to listen and ask for clarification. As the lesson progresses to "We do", the teacher and the class work together. The teacher asks prompting questions and works with struggling sub groups. The class answers questions alongside their classmates. Finally, the class should move to the "You do" portion of the lesson in which students independently answer questions relying solely on their notes while the teacher provides feedback.

Cornell Notes

Students will divide their paper into two columns to create Cornell notes (the left side will be more narrow than the right side). On the left side, students will pose essential questions or jot down titles and main ideas. On the right side, students will include notes, bullet points, images, and graphs. Beneath the two columns, students will synthesize their information by engaging in a personal reflection, a summary of what they learned, or by answering a question posed by the

teacher. Cornell notes allow students to organize information in a way that is easy to look up while reflecting on their learning at the same time.

Lesson Plans

Each lesson plan has an activator (a hook that draws the class in), teaching strategies (how the teacher will be facilitating learning and delivering content), and student activities (what the students will be working on). There is also at least one check for understanding throughout the lesson that allows the teacher to gauge student mastery in a quick, informal way.

Lesson 1-Introduction to Energy

Career: Solar Engineer (students will explore what a solar engineer does, how much they earn, and what they study in school)

Activator: Students will be presented with a cross-section of a house. Students will be asked to make a list of all the ways they used energy that day. Students will then be asked to ponder the question "How do these appliances work? Where does energy come from?"

Teaching Strategies:

Preview Vocabulary: Students will quickly draw a t-chart for renewable and nonrenewable. They will give examples and write definitions of each.

Mini Lab: To demonstrate the limited nature of nonrenewable energy, students will engage in a mini lab. There are both white and brown beans in a bag (about 100 brown and 20 white). White beans represent renewable energy and brown beans represent nonrenewable energy. Each turn, one person picks 10 beans from a bag. Each turn represents one year. After the beans are picked out, the white ones are returned to the bag and the brown ones do not (just like renewable energy can be used again and again but nonrenewable cannot). The next person picks ten beans and repeats the process. The students will continue to complete these steps until all of the brown beans have been removed from the bag. They will then see how many years (turns) it took until they ran out of brown beans. Repeat with 5. Repeat with 15.

Check for Understanding: There must be a balance of energy use between renewable and nonrenewable energy. Justify this statement using examples from the mini lab.

Student Activity:

Multimeter Lab (Appendix III): The concept that energy comes from the sun is vital in this unit as well as in our unit on ecosystems (as students begin to explore photosynthesis). This can be difficult for students to conceptualize. Through the use of a multimeter, students will be able to measure the energy provided by the sun and to visualize light as energy. Students will be able to experiment with solar cells, multimeters, batteries, and LEDs. To extend this lab, students will learn about photovoltaic cells and solar panels.

Lesson 2-Types of Energy

Career: Energy Lobbyist (students will explore what a lobbyist does, how much they earn, and what they study in school)

Activator: Students will complete a close read of three graphs that show energy use in North Carolina, California, and Texas. Students will compare and contrast energy use in North Carolina, California, and Texas (what types of energy they use, how much of each type they use). Students will then be prompted to question why these differences exist.

Check for Understanding: The teacher will conduct a gradual release to model how to answer EOG questions. Each of the three questions will be multiple choice and will be about analyzing graphs that surround energy use. The teacher will walk through the first one, the class will help with the second one, and the students will independently answer the last one.

Teaching Strategies:

Vocabulary Preview: The teacher will lead a mini lesson that examines the difference between "advantage" and "disadvantage". These vocabulary words are utilized often when discussing energy types. English Language Learners, and other students, will benefit from defining these second tier words. These words will be applied to scenarios other than energy so that students understand them outside the context of science first (for example: what are some advantages of doing your homework?)

Group Work: Students will be broken up into groups of four. These groups will be working together for the remainder of the unit. When creating these groups, it is wise for teachers to take ability level into account. For example, I would create a group with a wide range of students (a high-flyer, an English Language Learner, and two grade-level students would make a balanced group). As a group, students will become lobbyists for various types of energy (teachers will assign the type of energy to the students so that each type of energy is represented).

Student Activity: Each group will become experts and then advocates for their type of energy. They will conduct research using the graphic organizer and student resources in Appendix IV. They will learn about the basics of each energy type, about advantages, disadvantages, and environmental impact. When all students have completed their research independently, the group will compare and combine their knowledge to create a poster. This poster will be used to inform their classmates about their type of energy. Poster should be creative, colorful, neat, and informative.

Lesson 3-Exploring Renewable and Nonrenewable Sources

Career: Nuclear Engineer (students will explore what a nuclear engineer does, how much they earn, and what they study in school)

Activator: Students will watch a video that introduces the concept of Environmental Justice. As they are watching, students will create a mini time line of the Environmental Justice movement (this will include events such as the beginning of the movement, the creation of the EPA's office of Environmental Justice, and the Duke Coal Ash Spill). Students will turn and talk with their

partners to discuss the relationship between what they are learning about energy and the movement.

Teaching Strategies:

Gallery Walk: At the beginning of class students will engage in a gallery walk. The posters that were created the lesson before will be hung up around the room. With their graphic organizers, the students will walk around the room, view the posters, and fill out their graphic organizer. By the end of the gallery walk, all students should have information about all the types of energy.

Check for Understanding: Groups will receive a bag full of cut out cards. On the cards there will be information, facts, and pictures showing environmental damage. As a group, students will match the cards to the 9 types of energy that they apply to. This will be a competition (the first group to sort the cards correctly will win!)

Mini Lesson: The teacher will introduce the structure of the town hall debate that will take place during the next lesson. Students should already be familiar with the structure of an argument (from their ELA and debate class) but will receive a refresher as well as guidelines for applying their techniques to a scientific argument. In this hypothetical town hall debate, students will be appealing to the "CEO of Duke Energy" who is making a decision about the energy needs of North Carolina. Duke Energy will be determining what source of energy is going to be the best to invest in for the future. Currently, the most commonly used sources of energy in the state are petroleum and coal. Each group will make a case for their source of energy. They will have a chance to pose questions to other groups and rebut. The following are guidelines for how students should engage with one another, as well as how they will be graded:

Agree

+1

"I agree... and..." to build on an argument.

Disagree

+1

"I disagree because..." to refute an argument.

Question

+1

Ask a probing question to get more details about someone's argument.

Use Evidence

+2

Use a quote from the text to support an argument.

Devil's Advocate

+2

Pose a question or situation that is counter to a person's argument.

Connect

+2

Link a person's argument with another person's previous statement.

Distract

-1

Distract team or class from discussion.

Insult

-1

Be disrespectful to another person during the discussion.

Interrupt

-1

Speak while another person is speaking.

Student Activity: The groups will begin to develop their argument by completing a claim/warrant/argument worksheet (Appendix V). The resolution is "Petroleum and coal are the best sources of energy for the state of North Carolina" (because these are currently the most used sources). Based on their form of energy, groups will either confirm (the petroleum and coal groups) or negate (all other groups) this resolution. They will then create their own claim (for example: Solar energy is the best form of energy for the state of North Carolina) and back it up with the research they have completed over the past couple of days.

Lesson 4-Town Hall Debate

Career: Environmental Lawyer (students will explore what an environmental lawyer does, how much they earn, and what they study in school)

Activator: Students will receive an article that talks about the dangers that petroleum poses to the environment. They will close read this article, annotating the article for evidence that might back up their argument. Next, we will watch a quick video about the Duke Energy Coal Ash Spill.

Teaching Strategies:

The teacher will facilitate the town hall debate as the "CEO of Duke Energy". The teacher will monitor for correct student behavior (using the guidelines in lesson 3) and lead the structure of the debate (opening statements, questions, rebuttal, closing remarks).

Student Activity:

One representative from each group will read out their claim and supporting evidence. They have one minute each to do so. Students in their seats are listening and taking notes on what all other groups say. On their paper, they will have each of the group's names written out (solar, coal, wind, etc.). Using the guidelines presented in lesson 3, if they think that a group has a strong remark, they will tally one or two points under that team's name. They may also subtract points as needed. Representatives will return to their teams and together, the team will develop at least

three questions for the other teams. They have three minutes to do so. The intention of the questions is to poke holes in the other arguments. Questions will be written on index cards and given to the CEO (the teacher) to read. As the questions are read, teams are taking notes about questions directed towards them. The teams will then have five minutes to form their rebuttal using research and evidence from the articles and video from the activator (they will receive bonus points for referencing these sources). The representative from each group has two minutes to deliver the rebuttal. Finally, each team will receive three minutes to finalize the impact statement in the closing remarks. The intention of this statement is to draw at the heart strings and really finalize the argument. When this step is complete, students will count up the tally marks to determine the winner of the debate. Students will use a quick google survey to vote for who they determined to be the winner.

Check for Understanding: Students will write a letter addressed to the actual CEO of Duke Energy (these letters can be written on the school's letterhead and mailed if desired). In this letter, students will advocate for the type of energy they think is best for their community. This should be written in complete sentences and supported with evidence from research, debate, and the media sources. To support English Language Learners and Exceptional Children, outlines of letters with sentence stems can be created to assist with the structure.

Lesson 5-Energy Conservation

Career: City Planner (students will explore what a city planner does, how much they earn, and what they study in school)

Activator: Carbon Footprint Calculator: https://www3.epa.gov/carbon-footprint-calculator/. Using this link, students will be able to answer questions about their lifestyles and habits to determine how much carbon they are responsible for releasing into the atmosphere. Students will turn and talk to discuss ways they can reduce their carbon footprint (taking shorter showers, eating less meat, walking to football practice).

Teaching Strategies: Greenhouse Gas Simulation: https://phet.colorado.edu/en/simulation/greenhouse. As groups have been conducting research, scholars have been learning about environmental impacts associated with energy production. One such consequence that is consistently discussed is the release of greenhouse gasses. The teacher will walk through a simulation of what happens to the atmosphere when this occurs. The class will discuss what happens in the environment due to climate change: hurricanes, wildfire, corral bleaching, etc.

Student Activities: To understand the balance between providing for an expanding population and conserving resources, students will examine how an engineer might plan for the energy needs of an entire city. One activity that students can participate in is the "energy game" (appendix VI) in which students must balance the needs of the city with the environmental consequences of energy production. This requires students to know each type of energy, including the clean energy sources, as well as their costs and the technology required to implement them.

Check for Understanding: Students will take the unit assessment.

Pride Time Project

Over the course of 3 weeks (15 45-minute classes), students will conduct research on energy efficient homes, design an energy efficient home, and then create a model of one. Students should be placed into groups of three or four. The first week will be dedicated to research and experimentation, the second week will be dedicated to the construction of the house, and the third week will be dedicated to presentation and the lab write up. To preface this project, students will discuss two important factors when it comes to powering a home: the electricity bill and the environmental impact of the house. The goal of this project is for students to design a house that has a low carbon footprint, a low monthly electricity bill, and one that is aesthetically pleasing to consumers. The house must have at least two working lights powered by mini solar cells. When the houses are complete, the class will invite "consumers" (parents, teachers, and administrators) to come in and bid on the homes. The grade that the students receive will be based on the amount and price of the bids. Finally, the students will write an essay explaining what they learned and how they designed the home.

Week 1:

Students will be provided with a variety of sources that they may use to conduct research on energy efficient homes. They will explore a variety of options such as passive solar design, solar panels, solar water heaters, insulation, site selection, landscaping, window placement, cool roofs, and energy efficient appliances. They will test a variety of materials used for insulation (bubble wrap, a foam board, cardboard, plastic, and metal). This can be done with a thermometer and a light bulb. As they are conducting research, they will record their findings and start to think about what they want to incorporate into their houses. They will also create a list of potential materials that they may need.

https://www.energy.gov/energysaver/design/energy-efficient-home-design

https://www.bautexsystems.com/company/news-events/energy-efficient-home-design

https://www.techhive.com/article/2045771/a-floor-to-ceiling-tour-of-americas-most-energy-efficient-home.html

Week 2:

Students will begin to design their homes. Students should determine the location of the house, what materials they need, how many rooms the house will have, how to light up the house, and what it will look like (one or two stories, furniture, landscape, etc). They will then begin the design and construction of the house. Students are welcome to bring in any materials they would like to but the teacher should also provide some or all of the following materials.

Required materials

- Mini solar cells
- LEDs
- Scissors
- Electrical tape

Optional materials

- Cardboard boxes
- Shoes boxes
- Bubble wrap
- Plastic bottles
- Aluminum foil
- Aluminum cans
- Toothpicks
- Popsicle sticks
- Paint
- Manilla envelopes
- Glue
- Wire
- Paper clips

Week 3:

When the houses are complete, the presentation will begin. Students will have their houses set up and lit up. They will create a small flyer (such as the ones you might find online or at an open house) containing information about the house. On the flyer, students should record: location, monthly electric bill (https://www.cpi.coop/my-account/online-usage-calculator/), amenities, and asking price. Consumers (parents, teachers, administrators) will enter the room and receive monopoly money ($1=$1,000, $5=$5,000, $100=$100,000). They will go around the room, view the houses, read the flyers, and listen to students as they "pitch" their houses to the consumers. If a consumer if impressed with the house, they will bid on the house by offering the students the money (prices may be negotiated between the buyer and the student). Multiple consumers may bid on the same house. Whichever group has the most money at the end will earn the highest grade. To end the project, students will summarize the process in a lab write up in which they synthesize what they learned.

Appendix I

Standards

The North Carolina Essential Standard that this unit focuses on can be broken down as follows:

8.P.2: Explain the environmental implications associated with the various methods of obtaining, managing and using energy resources.[12]

- 8.P.2.1 Explain the environmental consequences of the various methods of obtaining, transforming, and distributing energy.
- 8.P.2.2 Explain the implications of the depletion of renewable and nonrenewable energy resources and the importance of conservation

Students will explore energy use and types of energy that are directly related to the state of North Carolina. They will explore how their homes are powered and will explore potential career paths. This standard is related to our seminar, the Art and Chemistry of Light, because most energy sources are derived from light, either directly or directly.

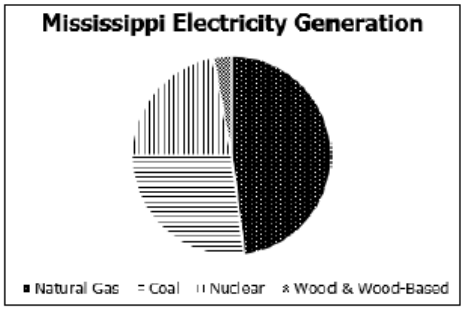
Appendix II

Assessment:

This assessment can be uploaded to a platform such as Mastery Connect. In order to achieve mastery, student need to earn at least an 80% (10 questions correct). To achieve near mastery, student must get 60% (8 questions correct).

Unit 5 Assessment: Environmental Consequences of Energy Usage

1. **Mississippi produces electricity for its citizens from several major sources.**



What percent of the electricity generated in Mississippi comes from sources that produce significant amounts of greenhouse gases such as carbon dioxide?

A 22%
B 27%
C 75%
D 78%

2. **Which example describes the use of a nonrenewable energy resource?**

A Gasoline is used to fuel a car.
B Sunlight is used to heat a home.
C Water is released through a dam.
D Wind turbines spin to generate electricity.

3. The use of which energy source causes the *most* damage to the environment?
   A. Fossil fuels
   B. Biomass
   C. Wind
   D. Hydropower

4. Which best describes a renewable energy source?
   A. Oil
   B. Coal
   C. Sunlight
   D. Petroleum

5. A family builds an environmentally-friendly home. They want to use an energy source that is the least dangerous to the environment. Which source of energy should they use to heat their home?

A. Coal
B. Natural gas
C. Nuclear power
D. Geothermal

6. Which of the following would have the most negative impact on hydroelectric power?

A. Frost
B. Drought
C. Shortage of uranium
D. Changing wind patterns

7. Why is solar energy seldom used as the sole energy source in households to provide electricity?

A. Solar energy can only be used with gasoline.
B. Solar power facilities destroy animal habitats.
C. Solar energy is difficult to capture and store for later use.
D. Solar energy panels are unattractive and homeowners do not like their appearance.

8. What are the advantages of using renewable energy sources to generate electricity?

A. Chemicals are released into the atmosphere.
B. It is expensive to maintain energy facilities.
C. It is produced by sustainable substances.
D. They are much less expensive than nonrenewable energy sources.

9. Why is renewable energy a better alternative to nonrenewable energy?

A. Renewable energy is less expensive than nonrenewable energy
B. Renewable energy is readily available, while nonrenewable energy supplies are limited
C. Renewable energy requires much less equipment maintenance than nonrenewable energy
D. Renewable energy harms the environment, while nonrenewable energy is environmentally friendly.

10. An environmental impact statement describes the possible effects a project might have on the environment. Which would *most likely* be included in an environmental impact statement concerning drilling for oil in Antarctica?

A. the costs of setting up drilling equipment
B. the effect of increased oil production on the economy
C. the effect of oil spills on organisms living in Antarctica
D. the estimated amount of oil sent to North America during the project

11. Which *best* explains why some people are against the use of nuclear energy?

A. There is not enough oil available.
B. There is not enough water available.
C. There is a risk of reactors working too slowly, wasting time, and not being cost-efficient.

D. There is a risk of reactors losing control, spreading radiation, and causing serious injuries.

12. Which *best* describes why fossil fuels are most often used for energy in the United States?
    A. Fossil fuels are found everywhere in the world.
    B. Fossil fuels can be quickly replaced in nature.
    C. Fossil fuels are easy to transport and burn.
    D. Fossil fuels have no harmful waste products.

Answer Key:

1. **D**
2. **A**
3. **A**
4. **C**
5. **D**
6. **B**
7. **C**
8. **C**
9. **B**
10. **C**
11. **D**
12. **C**

Appendix III

Solar Cell Lab

Materials:

- Multimeter
- Mini solar cell
- LED lights
- Batteries

Playing with solar cells:

1. Take a battery and a multi-meter. Measure the voltage and the current of the battery.

Voltage _____ Current _____

2. How much current does the LED draw from the battery, and what is the voltage rating on the package for the LED?

Voltage _____ Current _____

3. Using the sun or overhead projector, measure the V_{oc} (open circuit voltage) and the I_{sc} (short circuit current) of the solar cell.

V_{OC} _____ I_{SC} _____

4. Can you turn on the LED with the solar cell or multiple cells? How many does it take? Draw an accurate diagram.

Use the following website to further explore solar cells and solar energy.
https://www.renewableenergyworld.com/solar-energy/tech/solarpv.html

1. What are solar cells made out of?

2. Summarize how solar cells work.

3. What are some limits to using solar cells?

Appendix IV
Graphic
Organizer

	What is it?	Renewable or Nonrenewable	% used in NC	Interesting fact	Advantages (Pros)	Disadvantages (Cons)	Environmental Impact
Biomass							
Coal							
Geothermal							
Hydropower							
Natural Gas							

Petroleum							
Solar							
Nuclear							
Wind							

Student Resources:

https://docs.google.com/document/d/1I17zBDbGZLFxJz9PTzgH3L98Og8rZmcvVys2a91nHcA/edit?usp=sharing

The above resources include websites, videos, and articles that will allow students to explore each form of energy.

Appendix V

Claim/Warrant/ Impact

Resolution	
Affirm/ Negate	
Claim	
Warrant	**1.** **2.** **3.**
Impact	

Appendix VI

Energy Game

Congratulations! You have become the city planner of a new city. You are now in charge of creating this city. You have a budget of one million dollars to do so. Two of the most important factors that you need to consider are the energy needs of your city and the wellbeing of your citizens. As a leader of the city, you are in charge of making important decisions. You need to balance your budget, the amount of greenhouse gasses in the atmosphere, the energy needs of your city, and the health of your citizens.

Each decision that you make will result in a change in the amount of money you have and the amount of carbon dioxide in the air. You may not go above 1,000 tons of CO2 or run out of money. More than 1,000 tons of Greenhouse Gasses in the atmosphere will result in the death of your citizens...they will have breathing problems and their water will be too polluted to drink. If you go above or below these numbers, you need to backtrack and try again. To help you with this, you have received a tracker that will allow you to make calculations as necessary. You may also use the calculator on your computer. For each step, either add or subtract the amounts of each factor. You are starting the game with 0 tons of CO2 and 1,000,000 million dollars. You have also received a blank sheet of paper. At the end of the story, you will draw your city. Let's get started!

Before you start, pick a name for your city. Write this at the top of your blank sheet of paper.

Step 1: The first thing that you need to do is make housing for the people of your city. You have two choices.

A. Your first choice is to build sky scrapers in the middle of the city. This will cost you 300,000 dollars and it will add 300 tons of carbon dioxide to the atmosphere.
B. Your second choice is to build a neighborhood of houses. These houses will be powered with solar panels. If you choose this option, it will cost you 400,000 dollars, but it will only add 100 tons of CO2 to the atmosphere. Solar panels are expensive!

Step 2: The next thing you need to do as city planner is pick an energy source for your city.

A. Your first choice is to build a coal plant. Coal is a fossil fuel and produces a lot of greenhouse gasses. This will cost 100,000 dollars but it will add 250 tons of Carbon Dioxide to the atmosphere.
B. Your second choice is to build a wind power facility. This will cost you 200,000, but wind is clean so it will only put 50 tons of carbon dioxide in the atmosphere.

Step 3: How will your citizens get around the city?

A. Bus System: This will cost 100,000 dollars and produce 100 tons of CO2. Carpooling helps conserve energy! However, taking a bus is unreliable.
B. Bike Path: This will cost 50,000 and produce NO CO2! Biking to work does not use any energy at all. This is a great conservation method. Not everyone is able to bike though.

C. Subway: This will cost 200,000 dollars and produce 200 tons of CO2. This is a much faster and efficient way to travel.

Step 4: There are two big car industries that want to come to your city

A. Ferrari: This dealership will PAY YOU 200,000 dollars! These cars, although sweet, are not energy efficient. Therefore, having this company in your city will put out 150 tons of CO2.

B. Tesla: Tesla will PAY YOU 50,000 dollars. This company sells electric cars. This means that they do not rely on fossil fuels to move. As a result, they will only produce 50 tons of Greenhouse gasses.

Step 5: One of your advisors suggest building a park in the middle of the city. You will decide if you want to build this park.

A. Yes: Your health advisor suggest building a beautiful park with lots of vegetation in the middle of your city. This will be great for the health of your citizens AND all of the trees will absorb excess Carbon Dioxide in the atmosphere. This will cost you 100,000 dollars, BUT you can SUBTRACT 100 tons of CO2 from your tracker!

B. No: make no changes on your tracker

Step 6: Uh Oh! You need a backup form of energy in the case of emergencies.

A. Natural Gas: This is a fossil fuel so it is cheap but it will produce a lot of Carbon Dioxide. It will cost you 100,000 dollars, but it will put 200 tons of CO2 into the air.

B. Solar: Solar panels are expensive but great for the environment! It will cost you 200,000 dollars but it will only put 50 tons of CO2 into the air.

Step 7: The Panthers want to move their stadium to your new city. You need to decide if you would like them to or not.

A. Yes: The panthers will PAY YOU 250,000 dollars if you allow them to move to your city. However, it will cause you to clear trees and the construction process will emit 100 tons of CO2.

B. **No:** Make no changes to your tracker.

Step 8: Exxon wants to drill for oil in your city. You need to decide if you will allow them to do this.

A. Yes: Exxon will pay you 300,000 dollars for your natural resources. Drilling will damage your environment and petroleum, which is a fossil fuel, produces a lot of Greenhouse gasses. As a result, you need to add 200 tons of Carbon Dioxide to the atmosphere.

B. No: Make no changes to your tracker.

Step 9: Scientists from the federal government want to create a nuclear plant

A. Yes: This could be very dangerous to your citizens. In the case of an emergency, nuclear waste from the plan could be released and seriously harm or kill your citizens. Your river water will also become very hot when water is released from the power plant. Nuclear energy, though nonrenewable, does not release a large amount of greenhouse gasses. If you say yes, add 25 tons of CO2 to your tracker and the government will pay you

150,000 dollars.

B. **No:** Make no changes to your tracker.

Step 10: Your citizens want you to create a national park of the forest. As city planner, you will decide whether to listen to their petition.

A. **Yes:** There has been a petition going around saying that your citizens want to designate a forested area in your city as a National Park. This area has previously been used by a logging company to cut down trees and to use those trees as biomass. Biomass, though renewable, produces a lot of Carbon Dioxide. If you choose to designate this space as a National Park, it will be protected from logging. In addition to putting less CO2 into the atmosphere from burning the biomass, the trees will also be able to absorb more CO2 during photosynthesis. This will result in a SUBTRACTION of 200 tons of CO2 from the atmosphere! However, the logging company will takes its business elsewhere and it will cost money to take care of the park. It will cost you 200,000 thousand dollars.

B. **No:** Make no changes to your tracker.

Now, how did you do? How much money do you have? Did you exceed the maximum amount of Carbon Dioxide? Next, draw your city! Make sure your drawing includes all of the decisions that you chose.

Tracker

Step:	Choice Made	Carbon Dioxide (tons)	Money ($)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

End Notes

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[1] "World Population Prospects: The 2017 Revision | Multimedia Library - United Nations Department of Economic and Social Affairs."
[2] "Science, Technology, Engineering and Math: Education for Global Leadership | U.S. Department of Education."
[3] "Solar Photovoltaic Technology Basics | NREL."
[4] "Department of the Environment and Energy."
[5] "U.S. Energy Information Administration (EIA) - Consumption & Efficiency."
[6] "North Carolina - State Energy Profile Analysis - U.S. Energy Information Administration (EIA)."
[7] "Biomass - Energy Explained, Your Guide To Understanding Energy - Energy Information Administration."
[8] "Hydropower - Energy Explained, Your Guide To Understanding Energy - Energy Information Administration."
[9] "Wind Energy and the Environment - Energy Explained, Your Guide To Understanding Energy - Energy Information Administration."
[10] "What Is Nuclear Energy?"
[11] "Environmental Justice History | Department of Energy."
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