

How do renewable energy sources reduce our reliance on fossil fuel sources of energy?

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Abstract

This unit is designed for a middle school English or Social Studies classroom, where students have the opportunity to examine renewable and nonrenewable sources of energy and engage in reading, speaking, listening, and writing activities that allow students to debate the merits of the different sources. Students will be able to extend their learning in this unit to create a service project in which they spread awareness about the different energy sources that they learned about, helping to increase others' knowledge of the advantages and disadvantages to the different types of energy sources, along with taking a position for which source they feel would best meet our ever-increasing energy needs.

Content Objectives

Every year, I complete a service learning project with my sixth grade students through a program called Need in Deed. Need in Deed is an organization that brings guest speakers, professional development, and other resources to teachers' classrooms, where they will implement a service project based on a social issue that the class chose together through consensus during the school year. Seeing that global warming and climate change are at the forefront of many students' minds, I find myself confronting these issues most school years, hunting for resources that would be helpful for students to broaden their understanding of global warming and climate change. However, I often find myself not focusing on the possible solutions to this social issue...students learn extensively about the damage being done to the planet from greenhouse gas emissions and fossil fuels, and while there is often a big push to simply rid ourselves of using fossil fuels that contribute to global warming, we rarely focus on viable alternative options that would sustainably meet the energy needs that we still have as a country and world. Hence, this course will help me address the dearth of knowledge and options regarding renewable energy possibilities, and how these renewable energy possibilities could, in fact, replace current sources of energy production. Additionally, students will also be able to gain much more knowledge in *how* these renewable energy possibilities would work, allowing students to use this knowledge to further their argument for moving away from fossil fuels, allowing them to highlight with scientific knowledge the ways in which renewable energy possibilities would generate the same amount of energy we are currently consuming.

To achieve this goal of deepening my students' knowledge of renewable and non-renewable energy possibilities, I propose teaching the following: first, I would focus on non-renewable energy sources that we currently use to meet our energy needs. We would begin our focus on what non-renewable energy means, and how these sources are depletable, meaning that once they are gone, they are gone forever. We would also focus on what constitutes a non-renewable energy resource, such as coal, petroleum, and natural gas, and how each of these sources are used to produce energy. Finally, for these nonrenewable energy sources, we would discuss the ways in which these sources obtain their energy from the sun (the ONE and ONLY source of energy, the star in our solar system) through photosynthesis and carbon sequestration. We could even touch on how the process of photosynthesis converts the sun's energy into usable energy units using the equation $6\text{CO}_2 + 6\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2$.

After learning about our traditional sources of energy from fossil fuels, we then move on to learning about renewable energy sources, which have no pollutants and do not add any greenhouse gases to our atmosphere. We will examine the three main types of renewable energy: Photo voltaic cells (a.k.a. solar energy), wind turbines or Eolic, and low head hydroelectric energy generation. Before diving into the characteristics of each renewable energy system, we would first look at geographic constraints for each source, answering this main question: What geographical constraints exist for each renewable energy source? As students answer this question for each source, they will discover:

- Photo Voltaic cells need to be placed in areas that have a large proportion of sunlight during day light hours, along with a large amount of space required for the set up of all of the cells.
- Wind turbines need to be placed in places that are naturally windy, such as the tops of ridges or mountains or off-shore in the ocean.
- Low head hydroelectric systems need to be placed along sources of water that have enough flow to allow for substantial turning of the turbines to allow for sufficient generation of power.

Second, students will answer the question: "What economic constraints exist that prevent these sources of nonrenewable energy from being implemented today?" Students will discover:

- Photo voltaic cells can cost quite a bit to manufacture and install, along with the problem of storing energy collected during the day and ensuring it is available at night, when the sun is not shining.
- Wind turbines are very expensive to install, along with consideration of the problem when the wind is not blowing/as strong as needed to supply energy to meet the demand.
- Low head hydraulic systems need the installation of a dam and turbines which can be very costly to install.

Once students have considered the geographical and economic constraints of using each of the different sources of renewable energy, students will then be able to dive

in and begin learning about how each of these renewable energy sources actually collect energy that can be used to meet our energy demands. We would begin with Photo Voltaic cells, and how they collect the sun's energy and convert it into energy that can be consumed by humans. Students would learn about how a photo voltaic cell is a semiconductor that allows for the sun's energy to enter the photo voltaic cell, which is made of silicon, which then separates electrons from the silicon, creating free electrons that then enter the valence band of the photo voltaic cell, which then allows for the collection of these free electrons to be used for energy. We would then discuss how the PN Junction allows for the one-way flow of electrons that have been released from the silicon to be captured as energy that can be utilized by humans. Students would also be able to examine the photo voltaic cells and the role the photo voltaic effect has on the creation of energy. Students will also understand the scale of the photo voltaic cell, which is a part of a photo voltaic module, which is a part of the photo voltaic array, or modules that combine together to collect and transform energy into usable human sources. Students will learn how the charge controller then controls the amount of energy that goes into the batteries (most likely lead acid, 12 volt batteries that are used), not allowing more than 14 volts of current into the battery and not allowing less than 9 volts of current, as anything more or less than these amounts would degrade the lead acid battery, and the storage of the energy collected from the photo voltaic cells would then be compromised as well. Students will also learn about the role of inverters, and how the photo voltaic cells take direct current (DC) from the sun and the silicon and convert it into alternating current (AC) which is the form of electricity that we use in our homes.

Students will then go on to learn about wind turbines and how they work. Students may be surprised to learn that China is the world leader in production of Eolic energy, or energy from wind turbines, producing twice as much as the next leading producer, the United States. Additionally, while installing the wind turbines is expensive, it can, in fact, be only half as costly as photovoltaic cells. To generate energy, the turbines capture the wind's movement across the surface of the Earth, moving from areas of high pressure to areas of low pressure. The wind then turns the turbine, allowing for the transformation of the energy in the fluid to electrical energy through the rotation of the turbine. The rotor blades of the wind turbine serve as either a dynamo (DC current) or alternator (AC current) that are connected to a motor in the shaft.

The amount of energy that is able to be captured by wind turbines (also known as Power) is very heavily dependent on the velocity of the wind, which is related to the speed and direction of the wind. So, if the wind isn't blowing, little to no electrical energy can be developed, which presents a problem when there is still demand for electrical power when the wind isn't blowing. Even when the wind is blowing, all of that kinetic energy can't be captured by the turbine, as Betz's law states that the absolute maximum amount of energy that can be captured by a turbine is 59.3% of the kinetic energy present in the wind. Additionally, objects on the ground, including trees, houses, cars, etc. can impede the flow of the wind, creating friction and decreasing the velocity of

the wind. Hence, students will note that most wind turbines are not only quite tall, but that they are placed in either very high places (like on ridges or mountain tops) or on planes or the ocean where there are no barriers that could reduce the velocity of the wind that interacts with the turbine.

Another consideration to take into account is what to do with the energy that the wind turbines develop, which is referred to as the 'load.' The load can be either the capacity of the electrical grid to which the turbines are connected or the battery/battery bank that the turbine is connected to. Once the load is reached for either of these systems, the 'extra' electrical energy has to be dissipated using a resistor or a 'dummy load,' so that the extra energy can be dissipated as heat (as opposed to letting the turbine spin and generate electricity out of control).

The third energy source students will learn about is low head hydroelectric power generation. Similar to wind, moving water also possesses kinetic energy, as well as gravitational potential energy from going from a higher point to a lower point. However, unlike wind, water has 1000 times the density of wind, allowing for a great deal of mechanical energy generation. But, capturing energy from water is similar to wind in the sense that a turbine is still used, with a runner (or rotating wheel) and an electrical generator, such as a dynamo or motor is located. While the wind airfoils are very specifically designed to capture the kinetic energy of the wind, the water turbine has little spoons into which the water flows, spinning the rotating wheel.

The amount of flow determines the type of turbine that is used for electrical energy generation. For high heads, an 'impulse' turbine is used, whereas for medium heads a Francis turbine is used, as it takes advantage of both the gravitational and kinetic energy of a higher water flow. This is the most common and most efficient turbine in use today. Low head turbines are also used, and the 'propeller' design is the most efficient for this type, as it best captures the kinetic energy of the water since the gravitational potential energy is much lower because of the low head. The design for this type of hydroelectric power is best represented at how the Fairmount Water Works was built, where a small dam is built to direct water into a forbay, allowing large items to be deposited before allowing the water to run through the turbines (which was used to power the delivery of water into peoples' homes, not electricity at the time). There are many, many examples of this type of power still in use today, such as the Conowingo Power Dam on the Susquehanna River (U.S. Route 1 actually runs over the dam in Maryland) and the Hoover Dam on the Colorado River.

Finally, students will delve into one of the lesser known renewable energy sources, Biomass. Biomass is a renewable energy source because it refers to the burning of plant and animal waste, and we as humans generate a lot of animal and plant waste, whether it is farming and agricultural waste, food preparation and excess waste in schools, colleges, and restaurants, or even from sports venues, hotels, resorts, and

hospitals. Forestry and the burning of wood is also a part of biomass, and biomass is widely available simply because of the amount of waste/garbage we as humans generate, along with the availability of many trees (and replanting of trees) in forests. Even though the burning of biomass releases carbon, it is considered carbon neutral because it does not release more carbon than it absorbed over the plants' life cycle. Biomass is also very inexpensive, as it doesn't require the major investment of infrastructure that photovoltaic cells, wind turbines, or low head hydroelectric power generators need. It also gives food preparation facilities options for having their food waste be reused, such as restaurants that have their oil from their fryers reused as fuel for cars. Another positive benefit of using biomass is it can divert a large percentage (60-90%) of the garbage that would go into landfills, as the burning of biomass would reduce the need for more and larger landfills.

There are, however, many downsides to the burning of biomass for energy. It is much less efficient than fossil fuels, meaning that much more fuel is needed from biomass. Additionally, while the burning of biomass is carbon neutral, it is not free from emitting other gases, particularly methane, which contributes to global warming and climate change. Also, some argue that the burning of wood is just as bad as the burning of coal or other fossil fuels. The burning of massive amounts of wood for energy can also lead to the issue of deforestation, which is a rapidly growing problem in places like the Amazon in Brazil. While the Amazon is enormous, it is still being cut down at a very high rate, leading to problems in the future. And while many trees are often replanted to replace forestry that has been cut down, a large amount of space (and time) is necessary to regrow these forests so that they can again be used for biomass. Additionally, many plants (particularly woody trees like poplars and willows) are grown specifically to be used for energy development, and these trees and plants are often turned into pellets, bioethanol, or biogas, which is then burned for energy generation.

After this discussion of the different types of renewable electricity generation, students will have the ability to engage in informed discussions about the best next steps for individuals as well as collective leaders to take in investing in the development of these electricity sources. An important part for students to realize is that while these renewable energy sources are better in many ways from the burning of fossil fuels, none of these sources are perfect in that they all require either a large investment and development of infrastructure (which would generate large amounts of greenhouse gases) or they have other negative effects on plants and animals in the environment.

Teaching Strategies

As students will be grappling with all of these varied ideas in a sixth grade English class setting, many different discussion strategies will be used to not only elicit the students' own knowledge and understanding of these topics, but also to allow them to expand upon their knowledge with the many different concepts that we will cover.

One of the best (and well known) teaching strategies to start off a new unit with students is to use a K-W-L chart, where K stands for what students know, the W stands for what students want to know, and the L stands for what students learn about the topic throughout the unit. I, however, like to use a variant of this popular teaching strategy from Need in Deed, a service learning organization that works with teachers across Philadelphia. Need in Deed modified the K-W-L chart to include an H, or K-W-H-L, where the H stands for how students will learn/answer the questions they have. This extra addition to the K-W-L chart affords students much more autonomy and independence in their learning, allowing them to take charge of finding the sources they will need to answer the questions they pose in what they want to know. This activity also serves as an excellent pre-assessment for what students know about the topic and lays the groundwork for many of the lessons, articles, videos, and different websites/databases the students will then use in future activities.

A good teaching strategy that can open up students thoughts about renewable energy sources would be doing something called a Notice and Wonder. For this strategy, students would rotate around the classroom, observing photos of different parts of the different types of renewable energy sources, and the students would answer two questions: What do they notice about the different pictures they are observing? What do they wonder about the photo they are observing? These two questions can go a long way in getting students to think about what they are observing, as well as leading to many different questions and ideas about what they see. After students have observed all of the photos, the students would each choose one photo that really stood out to them, either because they were intrigued by it, they wanted to learn more about it, or it spoke to them in some other way. Once students have chosen their photo, they would do a deeper reflection about the photo, including what they think the picture is showing, how it makes them feel, connections that they can make to the photo, or anything that they like or dislike about the photo, and what should be done about the photo they observed. Students who chose the same photo can observe it together and then share their responses to these questions with each other and with the larger group as a whole.

A teaching strategy that allows students to begin exploration of the different renewable energy types, along with the economic and geographical implications of the different sources, would be using a strategy called "Save the Last Word for Me." This strategy allows students to first read an article about one of the different types of renewable energy, or a comparison of the different types of renewable energy. Students would then be placed in groups of 4, where each student has a role in the group to discuss the article. To help them prepare what to discuss, along with having another way in which students can participate, they would answer the following questions on a notecard:

Front:

- A sentence or quote that stood out for you
- A question that the material made you wonder about
- An idea you are thinking about after hearing, or seeing the material

Back:

- Now, write your thoughts about your sentence, quote, question, or idea.
- Make connections to other things you've read, or experiences you might have had that this material is bringing to mind.

After the students had a chance to answer these questions, they will then do the following:

- Form a group of 4.
- Count off: 1, 2, 3, 4.
- #1 shares what they wrote on the front of their card.
- #s 2, 3, & 4 **briefly** share their thoughts about what #1 shared.
- #1 shares why they chose their quote, question or idea, AND responds to what others shared.

This step is then repeated for all four students in the group. Once all students have had a chance to share, students take a minute to reflect on everything they heard from each other. Then, students have three minutes to have an open discussion with the other members of their group, with no restrictions on who speaks when. etc. After the open conversation, students would complete a short reflection in which they reflect on how this process made it easier or harder for them to share, and any other surprises or take aways they had from the conversation. Finally, the entire class can have a discussion about how this process either ensured everyone's voices were heard or stumbling blocks that students experienced in following this process.

As this is an English class, it would be imperative for students to create some pieces of writing around these renewable energy sources. For this part of the project, students could complete an argumentative piece of writing, where they research one of the renewable energy sources. Students could use a graphic organizer that allows them to organize their research and thinking around their chosen energy source in the following way:

- Introduction/Thesis: Students would create their first paragraph in which they introduce their energy source to their audience. Students are encouraged to start their piece with a good hook, or way to draw their audience into their piece. This can be a question or a surprising fact or statistic that would encourage their audience to keep reading. Another important component to this paragraph is their thesis, where they state why their energy source is the preferred renewable energy source for us to pursue investment in. Additionally, students would list their various reasons as to why they think their energy source is best.
- Body paragraphs: Students would construct three body paragraphs, where each paragraph would begin with a main idea, or reason, that would back up their thesis statement, and then include facts, examples and statistics that connect to the reason for that paragraph.
- Counterclaim and rebuttal: Students are then asked to think about ‘what the other side thinks,’ or imagine that they are someone who is making an argument against themselves. What would someone who does not support your energy source as the primary source say about your source? Where could they poke holes in your argument? Students think of counterclaims and then craft a rebuttal to show why their energy source (and argument) is still better than the other energy sources.
- Conclusion: Students would then complete their argumentative piece with a conclusion, restating/reminding their audience of their thesis statement and any other lasting facts or statistics or examples that they would want to leave their audience with.

This thinking will not only have students practice persuasive and argumentative writing but also think about the other side of an argument, and how others could make valid claims against what they are claiming, which will be very helpful in other activities.

Another teaching strategy that has worked well for me in my classes has been having students complete a group research project together. For this strategy, students would choose to research one of the types of renewable energy that they are interested in alongside a group of other students with the same interest. Students would not only research the how and why the renewable energy source works, but would also research the positive components associated with the source, along with the negative components of the energy source. Once students have completed their research, they can then begin creating a group presentation with other students who have chosen the same energy source. However, the students’ goal is to create as persuasive a presentation as possible, in an attempt to show to their peers’ why their energy source is the best source. As students create their presentations, they would focus not only on the best components of their energy source, but also think about counterclaims and rebuttals that students from different energy sources could raise with them and their source as they cited in their argumentative writing pieces.

To assess students for both their writing and their group research projects, I created a four point rubric that shows how students can exceed expectations, meet expectations, approach expectations or fall below expectations (the full rubric is included in the appendix, but I will briefly outline the main components of the rubric here). The

rubric is divided into five categories, which include design, knowledge, application, process, and presentation. For design, students want to ensure that they are directly addressing their audience, and ensure that they are making connections to their chosen social issue and their audience members. For knowledge, students must show that they have a large variety of facts and statistics from a variety of different sources, including websites, newspaper articles, databases, videos, and information from interviews and guest speakers that we have in class. For application, students demonstrate multiple meaningful connections to the social issue and the community in which they live, showing how addressing this social issue will improve their community through evidence. For process, students make sure that they are staying on track to complete all of their work, utilizing class time wisely and putting in time and effort at home, along with doing their fair share of work when working on the group project. Finally, presentation ensures that students are persuasive in how they communicate what they learned to their classmates, and whether they are able to engage/rally their classmates around their chosen social issue. This four point rubric ensures that students are well informed about the expectations prior to going into their work, and also allows for space if the students do not do well in one section of the rubric that they can still do well in the other areas and still earn a reasonable grade for the assignments.

Once the students feel that they have a good idea of how all of the different renewable energy resources work, they will have a chance to engage in something called a philosophical chair, which is similar to a debate, but is different in some key ways. First, there is a chair, similar to a moderator in a debate. The chair is the one who acknowledges people who want to speak. The students would be organized into different 'camps,' or the type of renewable electric generation that they feel would be the best type to further promote/support the development of in the United States and around the world. The students would then have a chance to research each of the different types of renewable energy generation and then choose the one that they feel is the best for developing further. Then, the students sit among their peers who agree with them on developing their specific type of renewable energy, and the students begin by issuing a statement about why they believe their type of renewable energy would be best to develop further. After these initial statements, the chair then recognizes students who would like to respond to statements that other students have said, ensuring that they are not only responding to what another student said, but also why they feel their renewable energy source would better meet the energy needs and environmental needs of our country and our planet. During this time, students are free to move to the different renewable energy sources as they feel persuaded by their peers' speeches, and can then argue about why they made the move to a different source. At the end of the philosophical chair, students can then share about the process in discussing/debating the different types of renewable energy, whether they were persuaded by their peers' arguments, and what they think would be the best source overall, or whether a combination of the different renewable energy sources would be the best plan to move forward (which, ideally is the goal, having students recognize that an 'all of the above'

approach makes the most sense for increasing our renewable energy sources as quickly as possible.

All of these different activities cover many PA State and National Standards in English Language Arts for sixth graders (a list of all of the standards covered is included in the appendix). One of the major umbrella standards for English Language Arts is Standard Area - CC.1.2: Reading Informational Text: Students read, understand, and respond to informational text – with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence. This standard is integral to the work students will be doing when they are researching a particular type of renewable energy for writing their persuasive paper as well as designing their group presentations. Other interrelated standards that connect to this standard include determining the central idea of a text and how it is conveyed through specific details, along with providing a summary of a text that is free from judgement/opinions, as well as well citing textual evidence to state what a text says explicitly as well as inferences and generalizations that can be drawn from a text.

Another major umbrella standard for sixth grade students in English Language Arts is Standard Area - CC.1.4: Writing: Students write for different purposes and audiences; Students write clear and focused text to convey a well-defined perspective and appropriate content. This content standard is particularly addressed in the persuasive/argumentative writing project that students would complete as part of this unit, where they not only research facts and information related to their chosen renewable energy source, but also craft a piece of writing that is persuasive to their classmates, convincing the class why their particular renewable energy source would be the best source to promote expanding. While students would certainly write informative/explanatory texts to examine a topic and convey ideas, concepts, and information clearly as well as develop and analyze the topic with relevant facts, definitions, concrete details, quotations, or other information and examples, they would also organize ideas, concepts, and information using strategies such as definition, classification, comparison/contrast, and cause/effect; use appropriate transitions to clarify the relationships among ideas and concepts; provide a concluding statement or section; include formatting when useful to aiding comprehension, along with ensuring that they identify and introduce their topic to their targeted audience. Many additional state and national standards also directly relate to the argumentative/persuasive writing project, including writing arguments to support claims, introducing and stating an opinion on a topic, using clear reasons and relevant evidence to support claims, using credible sources and demonstrating an understanding of the topic, as well as organize the claim(s) with clear reasons and evidence clearly; clarify relationships among claim(s) and reasons by using words, phrases, and clauses; provide a concluding statement or section that follows from the argument presented.

Finally, the last large umbrella state and national standard that is largely incorporated in this unit in English Language Arts is Standard Area - CC.1.5: Speaking

and Listening: Students present appropriately in formal speaking situations, listen critically, and respond intelligently as individuals or in group discussions. This standard is largely accomplished in the group research and persuasive presentation project, where students create a presentation collaboratively with their peers that is persuasive, trying to convince their peers that their chosen renewable energy source is the best one to pursue expanding. Interrelated standards that connect to this umbrella standard include engage effectively in a range of collaborative discussions, on grade-level topics, texts, and issues, building on others' ideas and expressing their own clearly, delineate a speaker's argument and specific claims by identifying specific reasons and evidence, and recognize arguments or claims not supported by factual evidence, Interpret information presented in diverse media and formats (e.g. visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study, interpret information presented in diverse media and formats (e.g. visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study, present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation, adapt a speech to a variety of contexts and tasks, and multimedia components and visual displays in presentations to clarify information.

Classroom Activities

STAGE 1: Desired Results		
Established Goals (Standards)	Transfer	
<ul style="list-style-type: none"> 1.2.5.D: Analyze multiple accounts of the same event or topic, noting important similarities and differences in the point of view they represent. 1.2.5.I: Integrate information from several texts on the same topic to demonstrate understanding of that topic. 1.2.5.G: Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently. 1.2.5.H: Determine how an author supports particular points in a text through reasons and evidence. 1.2.5.A: Determine two or more main ideas of a text and explain how they are 	<p><i>Students will be able to independently use their learning to reason through a variety of different energy sources, take a position on a source, and then use evidence to defend their position.</i></p>	
	Meaning	
	<p>Understandings</p> <ul style="list-style-type: none"> -There are many sides to an issue -Use evidence to defend a position on an issue -How to persuade others to their point of view 	<p>Essential Questions</p> <ul style="list-style-type: none"> -Why is this important to you? -Why is this important to the community? -How will you be impacted by this? -How will others be impacted by this?
	Acquisition of Knowledge and Skill	

<p>supported by key details; summarize the text.</p> <ul style="list-style-type: none"> 1.2.5.B: Cite textual evidence by quoting accurately from the text to explain what the text says explicitly and make inferences. 1.2.5.C: Explain the relationships or interactions between two or more individuals, events, ideas, or concepts in a text based on specific information in the text. 1.4.5.I: Provide reasons that are supported by facts and details; draw from credible sources. 1.4.5.H: Introduce the topic and state an opinion on the topic. 1.4.5.J: Create an organizational structure that includes related ideas grouped to support the writer's purpose; link opinion and reasons using words, phrases, and clauses; provide a concluding statement or section related to the opinion. 	<p>Students will know...</p> <ul style="list-style-type: none"> -There are many sources of energy that create problems in a community -Some sources affect some people more than others -Audience is important--people are mindful of their audience when they are trying to persuade them -There are many sides/opinions on a single issue, and that there often isn't one right answer. 	<p>Students will be skilled at...</p> <ul style="list-style-type: none"> -How to take a position -How to develop and defend an opinion -How to persuade others to agree with one's opinion -How reasoning/evidence leads to different understandings on an issue
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STAGE 2: Evidence	
Evaluative Criteria	Assessment Evidence
<p>Performance is judged in terms of...</p> <ul style="list-style-type: none"> -Presentation of energy source to class, and how persuasive they are in their presentation -Use of facts/evidence in defending opinions -Addressing the audience they are presenting to and how persuasive they are 	<p>Transfer Task(s)</p> <ul style="list-style-type: none"> -Presentation of issue to class, inclusive of facts, evidence, etc. -Participation in class discussions on different issues -Reflection sheets on activities <p>Other Evidence</p> <ul style="list-style-type: none"> -Notebook checks -3 x 5 cards with talking points on them

STAGE 3: Learning Plan

Day	Activities and Notes
Day1	Intro to Renewable energy- what is it and how does it work? What are the possibilities?
Day 2	Newspaper activity- finding articles about different energy sources. Students look for different sources that can be shared and discussed. What are questions you have about these sources? Write down all of the thoughts on chart paper to return to later.
Day 3	Photograph reflection- look at photos of different sources, choose one and reflect on the issues present.
Day 4	Info. gap game- add issues for consideration to Issue Parking Lot. Focus on one of the issues and delve more deeply- questions, what you know, etc.
Day 5	Interviewing peers and community members- develop questions to ask that probe about different energy sources in the community.
Day 6	Looking at a specific source: students delve deeply into one renewable energy source.
Day 7	If I could change one thing- students settle on one source that they would want to learn more about and say why.
Day 8	Intro. to project: based on source selection, students research, collaborate, and present their topic to the group as to why we should pursue that source collectively. Discuss being persuasive- what that looks like, sounds like. Students begin work on a piece of persuasive writing.
Day 9	Research collection day.
Day 10	Research collection day.
Day 11	How to write a persuasive piece of writing: who is your audience? How will you draw in your audience? Discuss creating the intro. paragraph: how to draw audiences in with a 'hook,' along with having a thesis statement.
Day 12	Writing body paragraphs.
Day 13	Writing body paragraphs.
Day 14	Conclusion: How to restate your thesis and what was important in your essay, along with leaving your audience with a 'final thought' in your piece.

Day 15	Writing celebration: sharing your writing with others and celebrating/toasting to everyone's great work!
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Resources

Bibliography for teachers

www.needindeed.org

This website provides teachers who want to include service learning in their classrooms with many resources, including a framework entitled My VOICE, which guides teachers in helping students take an idea about a social issue through to completion of a service project in their communities.

www.newsela.com

This website provides many articles, taken from reputable news sources such as the Associated Press and The New York Times, and 'translates' them into articles for students on a variety of different reading levels (as well as Spanish!), making current events more accessible for students.

Reading list for students

What is energy? Newsela.com

https://newsela.com/read/lib-what-is-energy/id/2001012414/?collection_id=2000000192&search_id=5c4a7282-755e-45fc-b323-bd892a679860

Short introduction to what energy is and the different types of energy that exist.

Where does energy come from? Newsela.com

https://newsela.com/read/lib-where-does-energy-come-from/id/2001012419/?collection_id=2000000192&search_id=9d8ab42a-260f-48d8-9568-8271215323e8

Excellent introductory article that explains the different types of energy sources and how it is generated, including nuclear, fossil fuels, and renewable sources.

Ten interesting things about energy: Newsela.com

<https://newsela.com/read/elem-sci-energy-facts/id/28499/>

Great, quick introduction to the main types of energy used, how and where they are used, and the development of new sources of energy.

Nonrenewable Energy: Newsela.com

<https://newsela.com/read/natgeo-non-renewable-resources/id/2000002214/>

Good overview of Nonrenewable Energy sources such as coal, petroleum, natural gas, and nuclear energy; give students background for how much of our energy is currently generated.

Drilling down into petroleum's impact on life on Earth: Newsela.com

<https://newsela.com/read/natgeo-petroleum/id/48026/>

Detailed article that covers the many ways in which petroleum drilling, refining, and use greatly affects creatures all over the planet, whether they are in the oceans or on land.

Types of Renewable Energy: Newsela.com. https://newsela.com/read/natgeo-renewable-energy/id/2000002211/?collection_id=2000000398&search_id=9eb33790-42cc-4ab7-8f78-c9ddc690ef5d

Excellent overview of the types of renewable energy with a basic explanation of each to get students thinking about renewable energy sources.

Issue Overview: Solar Energy. Newsela.com

https://newsela.com/read/overview-solar-energy/id/21122/?collection_id=2000000398&search_id=fb226c00-c776-43a8-b3a7-9d1ee89a8297

Gives students an explanation of where solar energy currently is in its development, along with background on how it got to where it is today, and arguments for its continued expansion.

An energy-producing house could be the wave of the future: Newsela.com

<https://newsela.com/read/lib-house-produces-more-energy/id/57510/>

This article very clearly explains how solar panels can be applied to people's homes and how they generate, or collect, energy from the sun that can then be applied to heating and cooling the house, along with charging electric cars.

Generating energy from the wind: Newsela.com

<https://newsela.com/read/natgeo-wind-energy/id/49407/>

In depth article that explains how windmills can be used to capture energy from the wind, how wind farms can be developed, and the advantages and challenges to using wind energy.

US wind farms get extended protection from penalties for killing eagles: Newsela.com

https://newsela.com/read/energy-eagles/id/2131/?search_id=8c5b931c-0bb1-4cc4-9830-5e8f901180a6

This article shows one of the disadvantages of wind energy, and the effect it has on our avian friends, along with the politics of regulating renewable energy and the benefits and non-monetary costs to using it.

Hydropower explained: Newsela.com

https://newsela.com/read/lib-hydropower-overview/id/55450/?collection_id=2000000192&search_id=83a7329d-c082-4ca9-903a-65221011f806

Good article that explains how hydropower relies on water, particularly moving water, to generate electricity, along with a short history of the use of hydropower in the United States.

Cow dung power comes clean in California: Newsela.com

https://newsela.com/read/poop-power/id/384/?search_id=08ac1cf4-c8e0-4841-9d9e-149b838b5d1b

This article provides good information for students on the background and feasibility of using biomass as a source of renewable energy.

Apple and its suppliers commit to clean and renewable energy sources: Newsela.com

https://newsela.com/read/apple-climate-change/id/51072/?collection_id=2000000398&search_id=8a52f350-0b25-4226-8831-f986a5cf5276

An article to get students thinking about the how (and why) companies would want to seek out renewable energy sources.

Future of renewable energy looks bright thanks to solar plane's journey: Newsela.com

https://newsela.com/read/solar-plane-round-the-world/id/20102/?search_id=3d0e5110-b0c9-47f6-be44-c74adae7078c

Fascinating article about the reaches and uses of renewable energy, and how it is being researched and tested much more and becoming more common in everyday life.

List of materials for classroom use

This unit is designed to be taught with minimal resources necessary in the classroom. However, it is expected that all students have access to a chromebook or other computer-like device, as this unit very heavily relies on students conducting research online using many different online sources, along with creating essays and group presentations with the use of technology as well. (Note: This unit was written during the Coronavirus Pandemic, where students were learning fully remotely for the duration of the school year).

Appendix

Appendix A

RUBRIC FOR PERSUASIVE WRITING AND ISSUE PRESENTATIONS

20-19: exceeds expectations

18-16: meets expectations

15-13: approaches expectations

12-0: does not meet expectations

	Exceeds Expectations	Meets Expectations	Approaching Expectations	Below Expectations
Design	Project directly addresses audience, intentionally addresses concerns of the community.	Project's audience is clear, intentionally targets a topic of concern to the community.	Project's audience is clear, topic may be of concern to the community.	Project's audience is unclear, unsure how topic is of concern to the community.
Knowledge	Facts, statistics, and other evidence (interview data and other primary sources) demonstrates importance of topic.	Many facts, statistics, and other evidence is provided to show importance of topic.	Some facts, statistics, and other evidence is provided to show importance of topic.	Few facts, statistics, and other evidence is provided to show importance of topic.
Application	Many meaningful connections are made to the project, citing evidence on how addressing it will improve our community.	Meaningful connections are made to the project and how addressing it will improve our community.	Some meaningful connections are made to the project and how it might improve our community.	Meaningful connections are not made to the project-unclear how it will improve our community.
Process	Deadlines are met ahead of schedule. Class time is used productively and appropriately; work also completed at home. Final project is turned in on time.	Deadlines are met. Class time is used productively and appropriately; work also completed at home. Final project is turned in on time.	Most deadlines are met. Class time is sometimes used productively and appropriately. Final project is turned in on time.	Deadlines are not met. Class time is not used productively or appropriately. Final project is not turned in on time.

Present ation	Presentation is very persuasive, engages/rallies class around importance of the topic.	Presentation is persuasive, convincing others that the topic is important.	Presentation is a little persuasive, not very convincing that the topic is important.	Presentation is not persuasive, does not convince others that the topic is important.
TOTAL POINTS				

Appendix B

STATE AND NATIONAL STANDARDS CONTAINED IN THIS UNIT

Standard Area - CC.1.2

Reading Informational Text: Students read, understand, and respond to informational text – with emphasis on comprehension, making connections among ideas and between texts with focus on textual evidence.

Standard - CC.1.2.6.A

Determine the central idea of a text and how it is conveyed through particular details; provide a summary of the text distinct from personal opinions or judgments.

Standard - CC.1.2.6.B

Cite textual evidence to support analysis of what the text says explicitly as well as inferences and/or generalizations drawn from the text.

Standard - CC.1.2.6.C

Analyze in detail how a key individual, event, or idea is introduced, illustrated, and elaborated in a text.

Standard - CC.1.2.6.D

Determine an author's point of view or purpose in a text and explain how it is conveyed in the text.

Standard - CC.1.2.6.E

Analyze the author's structure through the use of paragraphs, chapters, or sections.

Standard - CC.1.2.6.F

Determine the meaning of words and phrases as they are used in grade-level reading and content, including interpretation of figurative language in context.

Standard - CC.1.2.6.G

Integrate information presented in different media or formats (e.g. visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

Standard - CC.1.2.6.H

Evaluate an author's argument by examining claims and determining if they are supported by evidence.

Standard - CC.1.2.6.I

Examine how two authors present similar information in different types of text.

Standard - CC.1.2.6.J

Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Standard - CC.1.2.6.K

Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade-level reading and content, choosing flexibly from a range of strategies and tools.

Standard - CC.1.2.6.L

Read and comprehend literary non-fiction and informational text on grade level, reading independently and proficiently.

Standard Area - CC.1.4

Writing: Students write for different purposes and audiences. Students write clear and focused text to convey a well-defined perspective and appropriate content.

Standard - CC.1.4.6.A

Write informative/ explanatory texts to examine a topic and convey ideas, concepts, and information clearly.

Standard - CC.1.4.6.B

Identify and introduce the topic for the intended audience.

Standard - CC.1.4.6.C

Develop and analyze the topic with relevant facts, definitions, concrete details, quotations, or other information and examples; include graphics and multimedia when useful to aiding comprehension.

Standard - CC.1.4.6.D

Organize ideas, concepts, and information using strategies such as definition, classification, comparison/contrast, and cause/effect; use appropriate transitions to clarify the relationships among ideas and concepts; provide a concluding statement or section; include formatting when useful to aiding comprehension.

Standard - CC.1.4.6.E

Write with an awareness of the stylistic aspects of composition. • Use precise language and domain-specific vocabulary to inform about or explain the topic. • Use sentences of

varying lengths and complexities • Develop and maintain a consistent voice • Establish and maintain a formal style

Standard - CC.1.4.6.F

Demonstrate a grade-appropriate command of the conventions of standard English grammar, usage, capitalization, punctuation, and spelling.

Standard - CC.1.4.6.G

Write arguments to support claims.

Standard - CC.1.4.6.H

Introduce and state an opinion on a topic.

Standard - CC.1.4.6.I

Use clear reasons and relevant evidence to support claims, using credible sources and demonstrating an understanding of the topic.

Standard - CC.1.4.6.J

Organize the claim(s) with clear reasons and evidence clearly; clarify relationships among claim(s) and reasons by using words, phrases, and clauses; provide a concluding statement or section that follows from the argument presented.

Standard - CC.1.4.6.K

Write with an awareness of the stylistic aspects of composition. • Use precise language and domain-specific vocabulary to inform about or explain the topic. • Use sentences of varying lengths and complexities. • Develop and maintain a consistent voice • Establish and maintain a formal style.

Standard - CC.1.4.6.L

Demonstrate a grade-appropriate command of the conventions of standard English grammar, usage, capitalization, punctuation, and spelling.

Standard - CC.1.4.6.T

With guidance and support from peers and adults, develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach.

Standard - CC.1.4.6.U

Use technology, including the Internet, to produce and publish writing as well as to interact and collaborate with others; demonstrate sufficient command of keyboarding skills to type a minimum of three pages in a single sitting.

Standard - CC.1.4.6.V

Conduct short research projects to answer a question, drawing on several sources and refocusing the inquiry when appropriate.

Standard - CC.1.4.6.W

Gather relevant information from multiple print and digital sources; assess the credibility of each source; and quote or paraphrase the data and conclusions of other while avoiding plagiarism and providing basic bibliographic information for sources.

Standard - CC.1.4.6.X

Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes and audiences.

Standard Area - CC.1.5

Speaking and Listening: Students present appropriately in formal speaking situations, listen critically, and respond intelligently as individuals or in group discussions.

Standard - CC.1.5.6.A

Engage effectively in a range of collaborative discussions, on grade-level topics, texts, and issues, building on others' ideas and expressing their own clearly.

Standard - CC.1.5.6.B

Delineate a speaker's argument and specific claims by identifying specific reasons and evidence, and recognize arguments or claims not supported by factual evidence.

Standard - CC.1.5.6.C

Interpret information presented in diverse media and formats (e.g. visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study.

Standard - CC.1.5.6.D

Present claims and findings, sequencing ideas logically and using pertinent descriptions, facts, and details to accentuate main ideas or themes; use appropriate eye contact, adequate volume, and clear pronunciation.

Standard - CC.1.5.6.E

Adapt speech to a variety of contexts and tasks.

Standard - CC.1.5.6.F

Include multimedia components and visual displays in presentations to clarify information.

Standard - CC.1.5.6.G

Demonstrate command of the conventions of standard English when speaking based on grade 6 level and content.

