# Renewable Resources: The Path To The Future

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## Overview

This unit is designed for students in their middle school years but can be applied to high school as well. The unit is focused on the concepts behind alternative energy. The middle school students will focus on what renewable resources are being used and how they affect are environment. If applied to high school students, the unit can be modified to address standards that are covered in the high school science curriculum. The overarching theme of the unit will be two fold:

> *1) The students will become aware of the resources being depleted on our planet and the renewable resources that could replace them.*
> *2) Students will become active participants in improving and sustaining their own environment through the use of renewable resources.*

The duration of the unit will be for a period of one month for two to three days out of each week. It will take place towards the end of the year after any standardized testing. This will be advantageous for the unit since the weather conditions will be suitable to explore experiments outside of the school. The end of the year also provides the flexibility to fit the unit into any teacher's schedule.

The unit will begin by introducing the students to the energy crisis that has taken hold of our entire planet. This will include the human impact on the environment, the depletion of resources, and the overall health of our environment. Next. The students will examine the renewable resources that could solve our energy crisis by looking at examples of them in use. They will also look at resources that are not being used and the potential energy that the can provide. At this point students will begin to understand the relationships that are shared within a system and how the individual parts work together to perform one task. This will help them understand the complexities behind the systems used to create renewable energy. Students are expected to be independent for the duration of the unit using skills that have been addressed multiple times during the course of the year. Students will receive feedback on their progress in the form of guidance facilitation from the teacher and their peers. They will also continue to be formatively assessed throughout the entirety of the unit to ensure that the students are adequately progressing through the concepts. The will also assist with reinforcing their understanding of the concepts by identifying their weaknesses strengths on a daily basis.

The unit is preferably designed to be interdisciplinary and include many facets of learning. This will be accomplished by including the following disciplines throughout different sections in the unit: Literature, Math, and the Social Sciences. Scientific literature will be used for research and other purposes to address the literacy standards. Calculating amounts of energy will be used for looking at numerous graphs to address

math standards. Finally, understanding the human impact on resources and the planet will be used to address social science standards. There are many Pennsylvania science standards that will also be addressed during the unit and will be included in the appendix at the end of the unit. However, the standards the curriculum follows closest include the objectives covered in the Environmental Health section of the Philadelphia School District Science Curriculum.

**Rational:**

One of the more difficult struggles for any science teacher is convincing students of the importance and applicability of science to their world. Conveying this message to students is essential, since it is near impossible to teach them anything if they do not care or understand how the topic relates to them. By presenting them with topics that are timely and relative to their own lives they will have the motivation to sustain a curiosity for the subject material. They can see evidence of renewable energy almost everywhere they look, since it has been a major initiative for most prominent political figures in the country. They could also see evidence of it in the diversity of "green" products that are being released every other day. With such an awareness of renewable energy surrounding the students it would be tough for them to ignore how the topics discussed directly affects them. The middle school years are also a good time to introduce students to these types of topics. Since they are directly affected by the topics, early awareness could lead to one of the students pursuing the topics in the future and expanding on their knowledge of renewable energy. This possibly could lead to discoveries of better technologies or strategies to assist with the growing energy problem our world faces.

The implication is that building a strong foundation in science at an early age, can and will, produce future leaders in the world of science. Accomplishing these goals are essential to their learning if they are to be successful in the class. Even if they decide not to pursue a career in science, the hope is that they develop thinking processes that could help them in all aspects of life. When they have finished with the unit they should walk away knowing that the advancements in science today represent a continuum of contributions from many different types of people from all over the world. Without theses contributions humanity would not be where it is today. Recognition of the scientific accomplishments and advancements of today represent an acknowledgment and celebration of the cooperative efforts of all mankind. By understanding this, they will in turn understand that these contributions must be continued and that they are the ones who must make these contributions.

Renewable Energy is a unit that requires much research. The range of material can be examined in a variety of ways and taught using a multitude of strategies. Leaving out one piece of information could prevent the students from fully understanding the concepts. Therefore, its imperative that many, if not all, sides of the issues are addressed. However, it is easy to fall into the trap of trying to cover everything, consequently some parts of the lessons must be abbreviated for the sake of progressing through the material. The teacher will use their own discretion to decide which lessons or concepts will be abbreviated. As mentioned earlier, in order for the students to fully understand the

concepts they must be provided with an ample amount of information during the unit. The research will be completed in various ways including scientific literature, internet sources, interviews, and most importantly through the seminars that take place each week. My research will also include reading material on curriculums and how different approaches can be used to increase student understanding. This will be helpful in identifying new strategies that could motivate students and stimulate their curiosity for science. Some of the these strategies include but are not limited to, curriculum mapping, the gradual release of responsibility model, hands on activities, ongoing formal and informal assessments, and personal inquiry.

**Background:**

The particular facets of renewable energy that this curriculum will focus on will be the following: Electricity (Battery Power), Solar Energy, and Wind and Water Energy. These topics were chosen because they represent the renewable energies that are presently dominating today's discussion regarding the replacement of fossil fuels. They also represent the industries that will offer the most job opportunities for the students. Those two factors alone, make it easy to understand why it is important for the students to identify with those three aspects of renewable energy.

As we all know, the entire world is going through an energy crisis. There is a major demand to explore and discover alternative ways to provide energy to the people around the world. The exploration of these ideas has reached a fever pitch recently. This is due to variety of things, however one of the main causes comes from the major scare the people received in the summer of 2007 (Sachs) when gas and oil prices soared to new heights and forcing people to adapt and adjust their lifestyles. This was very unsettling for man people around the world, but particularly in America. A new light had been shown on the energy industry and people wanted answers. This forced major energy companies to invest in cleaner, more efficient ways to produce energy (Sachs). Consequently we are now faced with the reality that our current system of producing energy is no longer acceptable or practical. If we continued on with our present consumption energy using the same forms of energy that dominate today's usage, we will have completed depleted our resources by the year 2050 (Sachs). Not only will we no longer have means to supply the world with energy, but the devastation to world's environment could be insurmountable.

While the scare of summer 2007 definitely forced people to react more swiftly to our energy concerns, the problems we face now began long ago. The problem is the burning of fossil fuels and has been a growing problem for the world ever since the beginning of the Industrial Revolution. Fossil Fuels make up our main supply of energy its because of its overuse that we face so many environmental problems today. During in the Industrial Revolution the use of fossil fuels made the impossible seem possible. Its use powered machines, trains, factories and anything that else that required power to operate (Sachs). It was as if they had discovered gold, and could be the reason oil is referred to as "liquid gold". Fossil fuels provided, never seen before, power and at the time there was an abundance of supply. It seemed to be the perfect solution to many of

the problems of that time. Those problems included facing a exponentially growing population that needed food, shelter and supplies (Sachs). Machines made many of those problems easier to handle. Therefore, fossil fuels were and continue to be a great way to provide energy, however the problem came when people, primarily energy companies, began to exploit the energy source. Its overuse is what is causing the atmosphere to deteriorate and the planet to warm up. In other words, the excess use fossil fuels is causing global warming. It is not as though the planet is not used to the production of fossil fuels, however the rate of fossil fuel production is higher than its ever been. Fossil fuels can be produced by erupting volcanoes and other natural processes of the earth (Sachs) and has been occurring since the formation of the planet. However, once humans figured out how to manipulate and process the energy source, too much was being produced for our plant to handle.

The concept of energy also has to be explored in detail with the students. To fully understand how the energy initiative that is taking place it would benefit the students to explore all aspects of energy. The original source of energy, the sun, is something the students should be familiar with at this time. However, the physics behind energy might take time to cover with the students. Whatever the case, there are a few ideas that the students must be clear about including the formulas:

***Energy= Δ (delta) Work***
***Δ Work/Δ Time= Power***
***Force = mass x acceleration.***

Each week students will spend time covering each one of the formulas while identifying how they are applied to real life scenarios. Specifically, the students will focus on how the formulas are applied in the technologies being used for each renewable resource.

While dissecting the advantages and disadvantages of using renewable resources, students will also explore the affects of using nonrenewable resources. During this part of the unit, general quality of life will be emphasized. Students will look into the origin of nonrenewable resource and what its continued use could mean for our planet. By exploring both sides of the story students will gain perspective and begin to develop their own argument for or against renewable resources. For most people, it's a forgone conclusion that renewable resources are the way of the future, however getting to that point has proven to be very difficult. Students will be told that money is the main driving force behind the decision to remain with nonrenewable resource and not the well being of human kind. By gaining this understanding students should have an easier time predicting which resource will affect their lives in the future.

It is not as though people are just now becoming aware of our energy crisis. In the 60's President Richard Carter, foretold of the dire situation we now face regarding our dependence on oil (Sachs). Unfortunately, at the time there were other issues that took priority over energy dependence. It was not a necessity to concern the American people of issues that didn't seem to be a problem. Now, however, it is impossible to ignore which is the reason so mush emphasis is put on finding a solution to the problem.

Which brings us to the three concepts that the curriculum will focus on during the time the unit is covered.

The first concept that will be covered will be electricity and the batteries that transfer the electricity to the many machines we use daily. Batteries are important concept to visit because they will enable us to implement many of the renewable energies into our day-to-day lives (Sachs). An example of this can be seen with the huge emphasis that car companies have placed on the development of electrical cars. This is due to the fact that automobiles are the leading cause of CO2 emission in the world. There are hundreds of millions of cars circulating around the world because of the billions of people that need them. If populations continue to increase and the demand for cars continue at its current rate the amount of CO2 that will be produced will more than triple its current amount by the year 2030 (Santiago-Aviles, Renewable Energy Sources). Cleary, this would have a devastating effect on all aspects of our world. Already we can see direct evidence of global warming being intensified by CO2 emission in the unusual natural disasters that are taking place around the world. Whether it's the melting of the ice caps, devastating hurricanes, or drowning of rivers the natural disasters that are continuing to happen are caused by humans and the CO2 they are emitting from cars (Santiago-Aviles, Renewable Energy Sources)

Its is important for our students to understand that even though the scenarios explained sound dire and desperate, the problems can be resolved. One resolution can be the use of batteries in cars to drastically decrease the amount of CO2 emitting into our atmosphere. Batteries are a independent type of technology, meaning their function doesn't depend on too many external factors. The sun doesn't shine on demand and the wind does not blow everyday, but batteries will work in any condition, as long its mechanisms are not compromised. They are also very cost efficient, with high longevity and durability. Therefore the replacement of internal combustion vehicles (normal cars) with controlled emission vehicles (Electric or Hybrid cars) makes perfect sense.

When it comes to batteries, the quality of the battery depends on a few important features. For car companies, one of the main features of that they focus on is the low cost. In order for a battery to be of practical use, it must be made at a low cost. Another feature, is that it has a high energy and specific density, which will be explained later. The third feature most car companies focus on is the safety of the battery. Finally, a feature that is also becoming very important is that the battery be made to use non-faradic processes, so that it is able to recharge itself.

Most conventional batteries that are used in today's vehicles are made from either lead and acid or nickel and cadium. The problem with these batteries is that their ratio of energy density to specific density is not efficient enough, meaning for how much they weigh not enough energy is produced. There also is the fact that these batteries can be toxic to the environment. The alternative batteries that have been presented recently, do have some advantages over the conventional batteries, but still lack some key features for the consumer and car companies. For example, recent development in battery technology has lead to the use of Nickel-Metal Hydride which is classified as having moderate

energy and specific density. However, the problem with this battery is that is a at very high cost. The materials to make this battery and not easily accessible and causes the cost to soar. Fortunately, there is another solution. The Lithium battery is a technology that meets all of the key criteria that car companies look for and could potentially reverse the process of global warming. The reason is that is has a high energy density and specific density to match. Therfore this batter is very light and yet still produces a high amount of energy. In addition, new technologies are being frequently produced for this battery which could decrease the cost. As of now the only concern about the lithium is that it could be dangerous, especially if placed in a car. If a accident were to happen while you were driving a lithium battery powered car, the amount of voltage that would be released would be too much for any human to handle. Consequently, we will most likely not see this technology until those safety concerns can be addressed (Santiago-Aviles, Batteries).

The next unit that will be covered will deal with how wind and water can be used to provide renewable energy. With both wind and water the main mechanism for creating the energy is through the use of turbines. Turbines look very similar to windmills and essentially are used in the same way. Turbines take the energy created by the wind and water and use it to turn the blades on the turbine. The blades then activate gearboxes and other mechanisms inside of the turbine, which then generate energy. The theoretical and potential energy that can be produced from these technologies more than doubles the output of energy that is generated from the biomass energies that dominate our current sources of energy. While it not as dependable as battery energy, it still is more efficient and much less detrimental to our planet than the bio-fuels currently being used.

However, when it comes to wind, it is hard to predict when and where it will occur. Consequently, the location of wind turbines is critical to amount of energy that is produced. This means that there are specific places around the world where wind turbines would be more cost efficient and practical. One of the few places in America where there is a sufficient amount of wind is in California. In fact, it is one of the few places in America where you can find massive wind turbine farms. The location and the amount of wind the turbine receives is so important because energy is generated based on the blades angle of attack in relation to the wind, or how the blades face the wind. Another important reason location and amount of wind is makes such a difference is because of the relationship that is shared between the power of wind and the velocity at which it ravels. The relationship states that Pwind ~ V^3 which mean that each increase of 1 mph will grow the power of the wind exponentially. Therefore, not only does the location matter but also how the wind is gauged to avoid disastrous scenarios.

Water or tidal energy is on the other is very predictable as is seen when people predict high and low tides. Another advantage of using tidal energy is that it is consistent (Sanitago-Aviles, Wind Energy). As long as there is a moon and sun then there will always be tidal energy because of the universal force of gravity. The final major advantage that tidal energy provides is that the oceans provides the world's largest solar energy collection and storage system. It is stored directly as thermal heat and indirectly

through wind, waves and currents created by temperature differences. Unfortunately, this resource is embarrassingly under used especially when you are consider the fact that 60 mil kms^2 of tropical seas absorb the equivalent in heat content to ~245 billion barrels of oil . If .001 of this stored solar energy was converted to electric power, it could supply 20x the energy consumption of the US (Sanitago-Aviles, Wind Energy).

Solar energy will the final topic that the students will cover. Solar energy is a vast field and plays a major role in all aspects of renewable energy. Depending on how creative you get, you can attribute all of the resources that provide energy on this planet to the sun. That alone should be enough to understand the value of the sun's immense power. The sun is also the most available and democratic source of renewable energy on the planet.(Santiago-Aviles, Renewable Energy Sources) Unlike the resources mentioned earlier, the sun can not politicized or restricted due to human agenda. For as long as humans live they will have the seemingly limitless energy the sun provides and will be difficult if not impossible for humans to interrupt that. In fact, "In one minute, the sun provides enough energy to supply the world's needs for one year. In one day, it provides enough energy than the world's population could consume in 27 years." (Santiago-Aviles, Renewable Energy Sources) When looked at in detail the concepts behind renewable energy all stem from the sun. The sun gave birth to our planet and thus much of the components that make up our planet also make up the sun. Therefore, the processes we use to create energy, particularly when focused on renewable energy, are catalyzed by the behavior of the sun. Accordingly, this applies to the Wind, Water, Geothermal, and of course solar energy. The only limits we currently have on utilizing the sun's source of energy is identifying what strategies and technologies to use to harness its energy.

"The sun's energy is free, and the supply is abundant. All we have to do is find the way to use it. "(Santiago-Aviles, Renewable Energy Sources) This statement from a leading scientist, captures the irony of our energy issues. It also over simplifies the complexities behind the technologies use to harness the sun's power. There are several strategies used today to capture the sun's energy, however the real problem is figuring out how to do it practically and most importantly cheaply. The technologies that have come the closest to meeting that criteria are photovoltaic solar panels. The technology behind solar panels has been around for over 150 years and because of that many advancements have occurred during its existence. Solar panel production increases by around 50% every year making it the most widely used and most produced energy technology in the world (Santiago-Aviles, Fuel Cells). So the potential energy that the sun could provide is generally recognized, especially when it is understood that the sun's theoretical potential output of energy is around 3, 900, 000 EJ (exajoules) per year. That is only second to geothermal energy whose theoretical potential lies around 140, 000, 000 EJ per year (18pp). The potential of both sources of energy trump that of any of the resources that are widely used today. As a result, it is easy to understand why so much emphasis has been placed on photovoltaic technologies. Photovoltaics are best known as a method for generating electric power by using solar cells to convert energy from the sun into electricity. The photovoltaic effect refers to photons of light knocking electrons into a higher state of energy to create electricity (Santiago-Aviles, Fuel Cells). This

process is one that is simple in terms of it doesn't require many complex mechanisms or materials to be effective. Driven by advances in technology and increases in manufacturing scale and sophistication, the cost of photovoltaics has declined steadily since the first solar cells were manufactured. (Sanitago-Aviles, Fuel Cells)) In the future, solar cells and technologies associated with it will be dominate the energy industry. Hopefully, this will begin to turn back much of detrimental processes we have implemented on this planet or at the least curtail the processes from getting worse.

**Objectives:**

The objectives for the students intend to develop their processes of thinking while creating an awareness of human interaction with the environment. Students will have the necessary skills to identify problems with the environment and come up with solutions to the problems. This is intended to prepare them for the challenges they are certain to encounter as they reach adulthood. By preparing them in middle school, they begin to build a foundation in an industry that is sure to offer many opportunities for careers in their future. As mentioned earlier, the Energy Industry is one that seems to be growing at leaps and bounds. The variety of careers, as well as the demand for innovation will force the industry to search high and low for up and coming students to fill that void. Students who are more prepared for that transition would be the ones more capable to reap all the benefits that it is sure to offer.

Accordingly, it is extremely important that the skills that the industry most covets be emphasized to the students so that the skills will be ingrained in them by adulthood. If students are able to master thinking processes like, problem solving, creativity, and originality then they are sure to be in the running for the top tiers careers of the future. To complete this, the students will 1st have to become fully aware of their environmental conditions. This will help to reinforce many of the concepts that are being taught. This is especially true for a city like Philadelphia, where so much innovation and consciousness for greener energy already exist. Taking advantage of this is crucial since it will give the students a sense of ownership and pride. They will recognize that, Philadelphia, a city they live in, is considered one of the leaders and trailblazers for resolving the energy crisis.

For the 1st week students will be engaged in familiarizing themselves with renewable resources and the resources that are being depleted from this planet. Students will gain an understanding of the severity of the problems that our planet face and will be asked to identify possible resolutions for the problems. Students will also begin an introduction into Philadelphia and its environmental history. Here they will identify environmental concerns for past, present, and future and analyze the cause for the concern. Wrapping the week students will build on their research skills by completing a research paper on one particular aspect of energy utilization in Philadelphia.

The 2nd week will consist of the students understanding how global warming is affecting the planet and the major cause of the phenomenon. To understand this

thoroughly students will be guided through how electricity and particularly batteries could solve many of our energy problems. The students focus on hybrid and electric cars and the batteries that are used to supply the cars energy/power. By the end students should understand how automobiles are the leading producer of greenhouse gases why it is so vital to continue advancements in battery technology. The students will then identify places around Philadelphia who are utilizing the same technologies (West Philadelphia High School) and gain a deeper understanding of the technologies.

The 3rd week will highlight wind and water as two resources that are being investigated for wider use regarding energy creation. The students will understand how wind and water turbines work and the limitations that both technologies have encountered. They will also gain a deeper respect for the Ocean by understanding the immense amount of energy that is being stored and how it could potentially solve all of our energy problems. Following that they will become fully aware of the Philadelphia's green energy initiative by visiting a local sight that is promoting, developing, or using renewable energy for environmental sustainability.

The 4th and final week will direct its attention towards solar energy, which promises to be the most abundant and explored renewable energy of the future. Students will then understand the reasoning behind solar energy being the most widely used renewable resource of today. Understanding this will help the students become more prepared for the many career opportunities that wait for them in the near future.

**Strategies:**

The students will undergo multiple strategies to accomplish all of the objectives that have been laid out. Many of them will be cooperative type strategies where the students will group together and work various activities and experiments. The goal is to get the students to be self-thinkers and rely little on the teacher for guidance and more for facilitation. Students will also be engaged in activities focused on other disciplines, such as history, math, and literacy. They will accomplish this by researching Philadelphia's environmental history for social studies, analyzing and interpreting graphs and charts with calculations for math, and short responses as well as lots of reading material for literacy. Formative assessments will also implemented throughout the duration of the unit to ensure their understanding of the concepts. The formative assessments will take place everyday and will reflect the concepts that have been discussed during class.

Overall the primary strategy that will be implemented is The Gradual Release of Responsibility Model presented by Douglas Fisher and Nancy Frey in "Better Learning: Through Structured Teaching". The intention for this strategy is to put more responsibility in the hands of the students and less on the teacher (20BTbook). The students will then develop a self-ownership of their own work since they will have so much of their time and energy invested in their education. With this model, the students will have gained a type of mastery of the concepts by the end of the course. This will be due to their engagement and development throughout the unit. However, the foundation

for this type of learning has to worked on and cannot be done in one particular unit. Thus, the reason this unit is presented as a culminating, end of the year unit so that the teacher may have the entire year to establish rules and procedures on how to engage in such a unit. By the time they reach the unit, the types of activities and thinking processes will take place naturally.

**Activities:**

**Day 1:**

**Warm Up:**
Students will enter the room and immediately answer the following question in their journals: In a few sentences explain how you interact with your environment. Include the positive and negative ways you affect the environment.

**Direct Instruction:**
Students will then be prompted to follow along while the teacher introduces the students to the idea of energy and how its stored in their environment. This will be done with a powerpoint presentation with examples and explanations of the concepts provided throughout the presentation. The main focus will be on energy and its practical uses throughout the world. Therefore the students will 1st understand what energy is by identifying key formulas and theories developed by Scientist over the years. These include: Force=(mass)(acceleration), Work=Force x (change in y or motion), Energy = Change in Work and some others. Following this students will identify the practical uses of energy by observing them in action through examples on power point. These uses will include, natural gas, oil, coal, solar, wind, and a few others. Then they will be told that these forms of energy can be broken down into two categories: Nonrenewable resources and Renewable resources.

**Guided Practice:**
Students will then be given resources on particular form of energy and asked to complete a note sheet regarding the material in groups. The teacher will first guide the students through activity by explaining to them how to analytically read science literature. They will then complete the rest of the activity with their group.

**Independent Practice:**
Students will then individually complete summary questions the reinforce the lesson of the day

**Closing:**
Students will then complete the summary sheet and share out their summary answers to the class.

**Homework:**

Research and identify 2 environmental conservation companies in the Philadelphia area and explain what they do. If you cannot complete the research, then you must create a company of your own and explain what it will accomplish in Philadelphia.

**Day 2:**

**Warm Up:**
Students will enter the room and begin to answer the following question: Where have you heard the term Energy used before? Describe in your own words what Energy means to you.

**Direct Instruction:**
Students will perform an activity on this day that demonstrating what energy is and how it is manipulated and utilized throughout in real life applications. To do this, students will be informed of the proper definition of Energy and how it applies to the use of renewable energy. This will include the students identifying the equation that defines Energy **(Energy = Δ Work)** the way it will be used in the following activity.

**Guided Practice:**
Students will then observe the teacher demonstrate how the activity will be completed. They will be given all the materials needed and explained how each of the materials will be used in the activity. After modeling each step of the activity with the students and showing them what the finished product looks like they will begin to gather in their groups and organize their materials in preparation for completing the activity.

**Independent Practice:**
Students will then complete the "Roll Back Toy" Activity. Students will construct and the toy and perform activities that show how the toy uses energy. The students will use the instructions found in the appendix to guide them through the process. After completing the activity students will have a worksheet that accompanies the activity.

**Closing:**
Share results of activity with class

**Homework:**
Complete Energy Lab summary sheet given to them by the teacher

**Day 3:**
**(Students will need access to computers to complete this day's activities)**

**Warm Up:**

Explain why so many companies appear to be focusing so much of its attention on saving the environment.

**Direct Instruction:**
Students will be introduced through powerpoint the history Philadelphia has with the environment. The students will explore the past, present, and future of Philadelphia and the region have interacted with the environment. They will begin to understand the impact and importance of creating awareness of our environment.

**Guided Practice:**
Teacher will first model to the students how to properly use the internet to conduct research. The students will then be told to research and identify future of environmental conservation in Philadelphia. This includes what new technologies and strategies will be used, ways to live our life (eating, shopping, leisure), and family oriented changes.

**Independent Practice:**
Students will then proceed to write a two-paragraph summary explaining the futuristic technologies they have discovered and explain how it will work to save the environment. Then they must make an argument based off of their findings whether or not the technology will be something that could actually become a reality or whether it is too unrealistic to achieve.

**Closing:**
Share Research and discuss your argument with the class

**Homework:**
Research the past, current, and future of how electricity will be used. Then explain how it relates to the environment and global warming.

**Day 4:**

**Warm Up:**
What is electricity and how is it used? What daily activities do you do that use electricity?

**Direct Instruction:**
Students will look at powerpoint presentations to explain what electricity is and how it is used throughout our daily lives. Specifically students will spend time learning how electricity is stored and transferred through use of batteries. They also will begin to understand how batteries work and why so much focus has been given to batteries to eliminate our environmental concerns. They will be shown examples of the different types of batteries and explained why some batteries better than the environment when compared to others. This will help the students to understand why batteries are important. Following that the students will be introduced to the auto industry, which has

probably put the most focus on the advancement of battery technology because of their push for electrical and hybrid-electrical vehicles.

**Guided Practice:**
To help understand how batteries work teacher will demonstrate to the class how electricity is transferred without the use of typical batteries. The students will observe while the teacher performs the "Lemon Battery" activity that explains this phenomenon. Students will then identify the chemical reaction that takes place between the lemon and steel in the paper clip. After the teacher is done demonstrating, they will choose a couple of students to replicate the activity for the class to see.

**Independent Practice:**
Students will then be given information on two types of batteries: Lithium and Nickel based batteries. They will then group together and make a pros vs cons T-chart comparing the batteries.

**Closing:**
Share T-chart with class while teacher writes responses on big paper in front of the room for the whole class to see. The students will then fill in pros and cons that they might have missed with their groups. During this time discussion may break out about a particular advantage or disadvantage mentioned by a student. With time permitting the topic should be explored to give the students a deeper understanding of the lesson.

**Homework:**
Make a T-chart comparing automobiles that are electric vs automobiles that use combustible engines (the normal engine used in most cares)

**Day 5:**

**Warm Up:**
How have you heard the term Power used? What real world applications use the term power to explain how energy is used? Describe the term Power in your own words.

**Direct Instruction:**
To understand more about Energy students will perform an activity that demonstrates how power can be created and what power actually is. Students will do this by first understanding the scientific definition of the term power. They will be introduced to the equation**, Power = Work/ Δ Time**, and told how that applies to the activity they will be performing on this day. The students will also clearly understand that the ability to produce power is of the highest importance in the world of renewable energy. They will break down how people or companies that do a better job of producing power often do better than those who are weaker at the production o power.

**Guided Practice:**
Students will then be shown how they will complete the activity for the day. The students will then understand how power is created all the time and how the Power Activity will demonstrate that. Not many materials are needed for this activity; therefore the teacher will spend more time explaining how to organize the data they will collect from activity

**Independent Practice:**
Students will then take the information they have acquired from the first parts of the class and apply to them the "Producing Power" activity. The activity will require the students to be active and run up and down steps measuring the amount of power produced during the time to took them to run the steps along with the slope of the steps. All instructions for the experiment can be found in the Appendix.

**Closing:**
Share arguments with the class and discuss the validity of observations and conclusions made from the student's analysis of the activity.

**Homework:**
Complete data sheet and questions that go along with the activity performed in class.

**Day 6:**

Students will perform "Generate Electricity" activity to reinforce ideas learned during the week

***Refer to Appendix to see the activity that is planned for the day***

**Day 7:**

**Warm Up:**
Two other renewable resources that are used for energy are wind and water. Hypothesize how they might be used to produce energy.

**Directed Instruction:**
Students will observe how win and water are used create energy for practical uses through powerpoint presentations. They will look at examples of each resource and how manipulating the resource's behavior can create energy. They will begin to understand the benefits of each and the potential that they have for producing environmental sustainability. Wind energy will be given more attention since it is more widely explored throughout the world. However, they will also recognize that water is more easily manipulated than wind and is a mystery to many while it is so under utilized.

**Guided Practice:**
Students observe the affect wind and water have on various objects displayed by the teacher. The students will record in their journals how wind and water affect the objects. Then the teacher will demonstrate how to create a weather vane or wind sock that will be created at one of the stations the students will work at following the demonstration. Another station will also include analyzing the power of stored water or hydropower plants, seen as dams in the real world. Therefore the teacher will demonstrate how this activity is to be completed at the station. (See Appendix for details about activities)

**Independent Practice:**
Students will be grouped together and separated into stations. At these stations students will complete activities that were demonstrated to them by the teacher. After completion of the activity at their station the students will fill out the appropriate section of the worksheet given to them. When they have completed the questions the students will move to the next station and complete the worksheet after they have finished the activity

**Closing:**
Students will complete handouts regarding stations they will have just completed

**Homework:**
Students will use two articles given to them by the teacher, which discuss either water or wind energy, and explain in paragraph detailing which method would work better in today's world. Also, list the advantages and disadvantages from both articles.

**Day 8:**

**Warm Up:**
If it makes so much sense to go the route of renewable resources, then why has it proven to be so difficult to get more people to accept the use of renewable resources over nonrenewable resources?

**Directed Instruction:**
Today the students will spend time breaking down both sides of the nonrenewable energy vs. renewable energy argument. They will be introduced to facts and information about why each side of the argument can be seen advantageous. However more importantly, the teacher should try to emphasize to the students the importance of using renewable resources over nonrenewable for the health of the planet and the general quality of life that it can give every person. Following this they will identify how renewable energy has been used all over the world effectively to reinforce the advantage renewable has over nonrenewable.

**Guided Practice:**
Students will observe the teacher demonstrate how the materials are used for the activity and the proper way to complete the activity.

**Independent Practice:**
Students will complete the activity "The Answer Is Blowing In The Wind" activity in groups and they will answer a follow up worksheet to reinforce the ideas learned during the activity. (See Appendix for details on the activity)

**Closing:**
Share out answers to summary sheet

**Homework:**
Identify three objects from home that could be used to produce energy and then explain how the details of how it could be used.

**Day 9:**

*Students will take a field trip to a local location using encouraging, producing, or dealing with some aspect of environmental sustainability.*

**Day 10:**

**Warm Up:**
Solar panels are the most widely used and explored resource out of all of the renewable resources. Explain in a few sentences why you think this is the case.

**Direct Instruction:**
Students will be introduced to the most popular of all renewable resources and understand why solar energy seems to be the most viable option to replace our current energy resources. This will begin by the students being shown powerpoint slides the describe the process of converting solar energy into energy people can use for their daily activities. They will be shown the history of solar energy and how far it has advanced in recent years. Then they will be shown examples of solar energy being put to use. Following this students will identify the many career opportunities that are available in the solar energy industry. Particularly, students will focus on careers that exist in Philadelphia that are being offered by the PECO and Comcast, two of the biggest companies in the area.

**Guided Practice:**
The teacher will then display to the students on the board, examples of careers that are currently being offered by the two companies on their website. After that, the teacher will read through one opportunity and explain to them the advantages and disadvantages to choosing the selected career. The impact as well as how it relates to the students will also pulled out from the selection and discussed with the class.

**Independent Practice:**
Students will then be given the option of choosing from a selection of careers that might be of interest to them. Once they have selected a career, they will be asked to extract the same pieces of information that were gone over with the teacher. Once they have extracted the appropriate information they will be asked to write a one page summary explaining why they selected their particular career and how it can be related to their lives. They will also have to explain whether or not this could be a career that they would pursue in the future.

**Closing:**
Students will share their thoughts on why they selected their careers

**Homework:**
Research and identify three other careers that might interest in regards to energy. Explain why you selected each career in a paragraph

**Day 11:**

Students will take a culminating field trip to two "green" companies in the Philadelphia area. The two companies are Comcast and PECO and they will provide tours of their building explaining how their building are good or the environment. They will also explain what actions they are taking to create environmental sustainability.

**Day 12:**

On the last day of this unit students will have the opportunity to reflect on field trip from the previous day as well as what they have learned during the entire unit. Following this students will also have the opportunity to select one of the following activities to complete to be used to assess their complete understanding of the unit. The two activities are: "Solar Cell Power: Series or Parallel" or "Building a Better Solar Greenhouse"

***See Appendix for "Solar Cell Power: Series or Parallel" and "Building a Better Solar Greenhouse" activities***

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**Activity Appendix:**

1) Roll-Back Toy
2) Power: How Much Power Can You Generate?
3) Generate Electricity
4) Wind Sock
5) The Answer is Blowing In The Wind
6) Solar Cell Power: Series or Parallel?
7) Building a Better Solar Greenhouse

**1. Roll-back Toy**

Materials:

- A small container that can be laid on its side and rolled and have a hole punched in its top and bottom (such as a clear plastic soda bottle or coffee can)  *Note:* Using a clear soda bottle helps to demonstrate what is happening inside.
- One thick rubber band about 3-4 inches long (8-10 cm)
- Two tooth picks or paper clips
- Several washers tied together with a twist tie or another weighting device that will fit through the opening of a soda bottle or the container being used.
- String
- Hole punch tool or scissors

**Procedure:** Punch a hole through the lid and the bottom of the container. Take the lid off the container. Thread a string through the bottom of the container and pull it through the lidless top of the container (make sure there is still string hanging out the bottom end).

Tie the end of the string that you pulled through the top to one end of the rubber band (you will use the string as a lead to help thread the rubber band through the container).

Tape the washers together and then connect them to the middle of one section of the rubber band (do not tape the strands of the rubber band together).

Put the end of the rubber band (the end not connected to the string) through the container lid. Use a toothpick to secure the band so that it does not slip inside the container (put the toothpick through the end loop of the rubber band that remains outside the hole). Put the lid on the container (making sure the string is still sticking out the other end).

Carefully pull on the thread until the rubber band comes through the hole. Secure the

band with the second tooth pick. Be sure to situate the weight so it is in the center of the container and does not touch the sides. Your roll-back toy is ready to go!

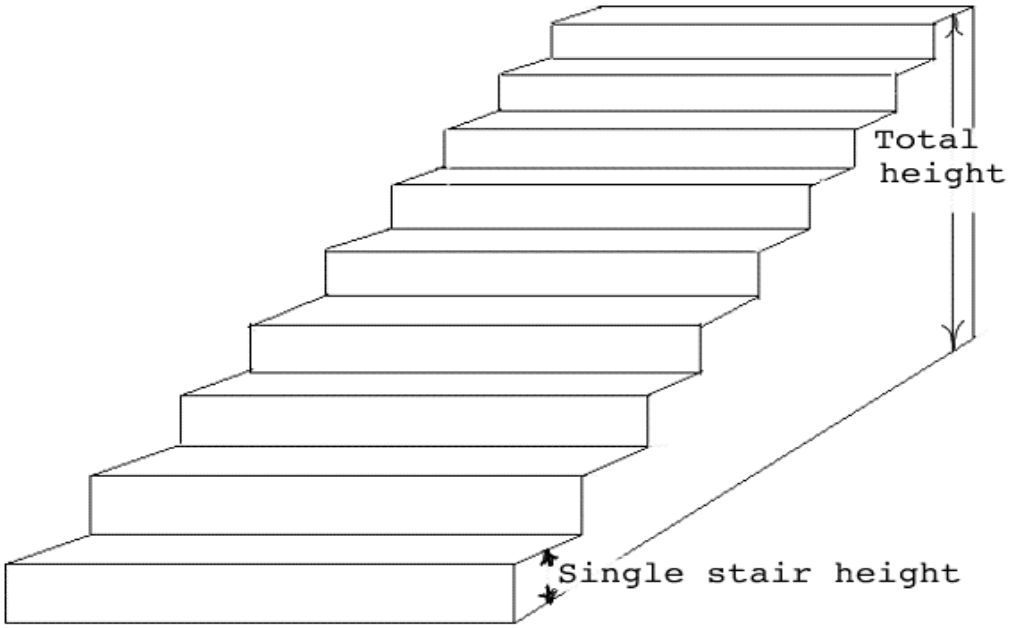
**Activity:** Roll the toy and watch as the weight holds one strand of the rubber band stationary while the free side twists around. The farther the toy is rolled the more potential energy. Release and watch the toy roll back towards you demonstrating kinetic energy. This would be a great activity to have races in the classroom to see who could devise the roll-back toy with the greatest potential energy.

## 2). How much power can you develop?

You could run up a flight of stairs rapidly or you could climb the same stairs very slowly. Either way, you do the same amount of work because you apply the same force (equal to your weight) through the same distance (the height of the stairs.) **Power is work per time.** That is, if you do the same amount of work in a shorter time, it takes more power. Two cars might weigh the same and they might climb the same hill, hence they do the same amount of work. But if one of the cars is a clunkey old car and the other car is a powerful sports car, the sports car can climb the hill much faster because it has a more powerful engine. In this experiment we are going to see how many watts of power you can develop.

**Finding the force you must exert.** Every time you weigh yourself, you are measuring the force that the earth pulls down on you (this is called your weight) and you are also measuring how hard the scale pushes upward on the bottoms of your feet. If you weigh 80 pounds, the scale must push upward on you with exactly 80 pounds. Most people find it peculiar that the scale pushes upward on them when they weigh themselves, but it always will. If you weigh 80 pounds and are standing on the floor, the floor will push up on the bottoms of you feet with a force of 80 pounds. (This is very hard to understand but it is true--think of pressing the binder clip against the wall--what must the wall do to the binder clip? Isaac Newton was the first to understand this and his ideas about action and reaction forces have revolutionized the way we think.) The first thing you must do in this experiment is to weigh yourself. You will probably have to weigh yourself in pounds but your teacher will explain how you will convert this to the metric unit of force, the newton. (For example, an 80 pound person will also weigh 356 newtons, the metric unit of force.)

**Measuring the distance you will climb**. Your teacher will explain how to find the height of the stairs you will climb. This height will be in the metric unit of distance, the meter. Even through you will run up at an angle, you will only need to know the height you climb.




**Computing the amount of power you develop:** Power is the amount of work you do divided by the amount of time it took to do the work. The work you did in climbing the stairs is the force you applied (your weight) times the distance you moved upward (the height of the stairs.) That is:

**Work** (in joules) = your weight (in newtons) X the height of the stairs (in meters.)

Now the power you developed is the work you did divided by the time it took, or:

**Power** (in watts) = work (in joules) divided by the time (in seconds.)

If we call the time it took for you to climb the stairs in seconds, T, the height of the stairs in meters, h, your weight in newtons, W, then to find the power you developed in watts, P, the following formula restates what we said above:

**P = W x h/t**

**Computing the work you will do.** Since work is force times the distance through which the force acts, you will find the amount of work you do in climbing the stairs by multiplying your weight in newtons by the height of the stairs in meters. **Force** measured in **newtons**, times **distance** measured in **meters**, gives the metric unit of **work or energy**, and it is called the **joule**. (For example if an 80 pound person climbs a flight of stairs which goes up one floor, this person will exert a force of about 360 newtons through a distance of about 4 meters, hence the person will do about 1440 joules of work.)

**Measuring the time it takes for you to climb the stairs**: Your teacher or another

student will measure how much time in seconds it will take for you to climb the stairs. Run as fast as you can, skip stairs if you want to, pull on the hand rail if it helps but don't fall and hurt yourself! The faster you climb the stairs, the more power you will develop.

## 3. How Can We Generate Electricity?

**CONCEPT**
To understand the importance of renewable energy, students will learn how electricity is made.

**GOAL** Students will realize that to make electricity, something has to "turn the turbine." (Examples: steam from burning coal, oil, or heating from sunlight (solar-thermal); or falling water; or wind; etc.)

**MATERIALS** For each group of students, 100 cm of bare copper wire; bar magnet; electric meter (i.e., galvanometer or milliammeter, hollow tube such as a toilet paper roll; student sheet, "How Can You Make Electricity With a Magnet?", and Energy Sources that Turn the Turbine.

**HELPFUL HINTS USING TLM** Invite: Ask students where the electricity comes from to light the lights in the room, to run the overhead projector, to run the stove, refrigerator, etc. Write key vocabulary words on the board as they use them. Discover. Create: see below.

**BACKGROUND**
Most electricity is commercially produced using large generators. The generator consists of two parts: the armature, which is a large coil of wire, and magnets, which are usually electromagnets. By moving the coil of wire through the field of the magnets, a current (a flow of electrons) is induced (produced in the wire.
It does not matter whether the coil of wire moves through the magnetic field or whether the magnetic field moves over the wire. The current is always produced in the wire.
As you can see, something has to turn the coil or the magnet. Without energy to do that turning, no electricity can be produced. In an electric generating plant, that energy usually comes from a large windmill-type apparatus called a turbine. The turbine has many blades attached to a shaft.
The turbine is usually spun by hot, expanding steam from a boiler. And the steam is produced by burning fossil fuels or using a nuclear reaction to heat water. However, running water (hydropower) can also be used to spin a turbine. So can wind.
When the turbine turns, its shaft turns. The shaft is attached either to the armature (coils) or to the magnet, and when it turns, it generates electricity.
In order for the current to flow, there must be a complete circuit connected to the wire that breaks the magnetic field. In other words, the end and the beginning of the wire are connected, making a complete loop. The electrical current that is produced is a flow of electrons, in the wire, which can be utilized in various ways. If the end and the beginning of the wire are connected through a radio, for example, the radio will play.

**ACTIVITY**
1. Break students into groups of 2 or 3. Hand out the lab sheet: "How Can y ou Make Electricity With a Magnet?"
2. As students work through the activity, introduce the idea that an electric current is a flow of electrons. A magnet can pull tacks or nails, it can also pull electrons.
3. Also ask students: "Do you suppose it makes any difference if we move the magnet in different directions?" Have them try it. The largest current will be produced when the magnet moves perpendicular to the coils.
4. Also ask students: "Are there any other things you can think of that might change the amount of current produced?"
5. Once students have completed the worksheet questions, ask them to construct a turbine generator using some form of renewable energy (perhaps wind or water) to do the turning. Hand out "Energy Sources that Turn the Turbine" as a guide for this activity.

## 5. The Answer Is Blowing In The Wind

**CONCEPT**
Students will learn that rotors, blades and wind speed are factors that determine how much electricity can be generated by a windmill.

**GOAL** Students will make three modern wind machines and determine which factors affect how well they turn with the least amount of wind.

**MATERIALS** Refer to "How Much Wind is Needed to Turn a Modern Wind Machine?" and "How Can you Measure Wind Energy?"

**HELPFUL HINTS USING TLM** Invite: Ask students what windmills in Holland are used for? (Surprisingly, not for energy! They are used to grind grain.) Refer to the previous activity to remind students that electricity is generated from something turning the shaft of a turbine. (Students that built a windmill in the last activity can use it as one of their "modern" wind machines.) Discover. Create. Ask Questions: refer to "How Much Wind is Needed to Turn a Modern Wind Machine?"

**ACTIVITY**
Refer to "How Much Wind is Needed to Turn a Modern Wind Machine?"

**PA Standards Addressed During Unit:**

- 3.2.7.A- Inquiry and Design: Explain and apply scientific and technological knowledge
- 3.2.7.B-Inquiry and Design: Apply process knowledge to make and interpret observations
- 4.6.7.A-Ecosystems and Their Interactions: Explain the flow of energy and matter from organism to organism within a ecosystem
- 3.1.7. A- Unifying Themes: Explain the parts of a simple system and their relationship to each other
- 4.2.7.B- Examine the Renewability of Resources: Examine the renewability of resources
- 4.3.7.A- Environmental Health: Identify environmental health issues
- 4.3.7.B- Environmental Health: Describe how humans actions affect the health of the environment
- 4.8.7.B- Humans and the Environment: Explain how people use natural resources