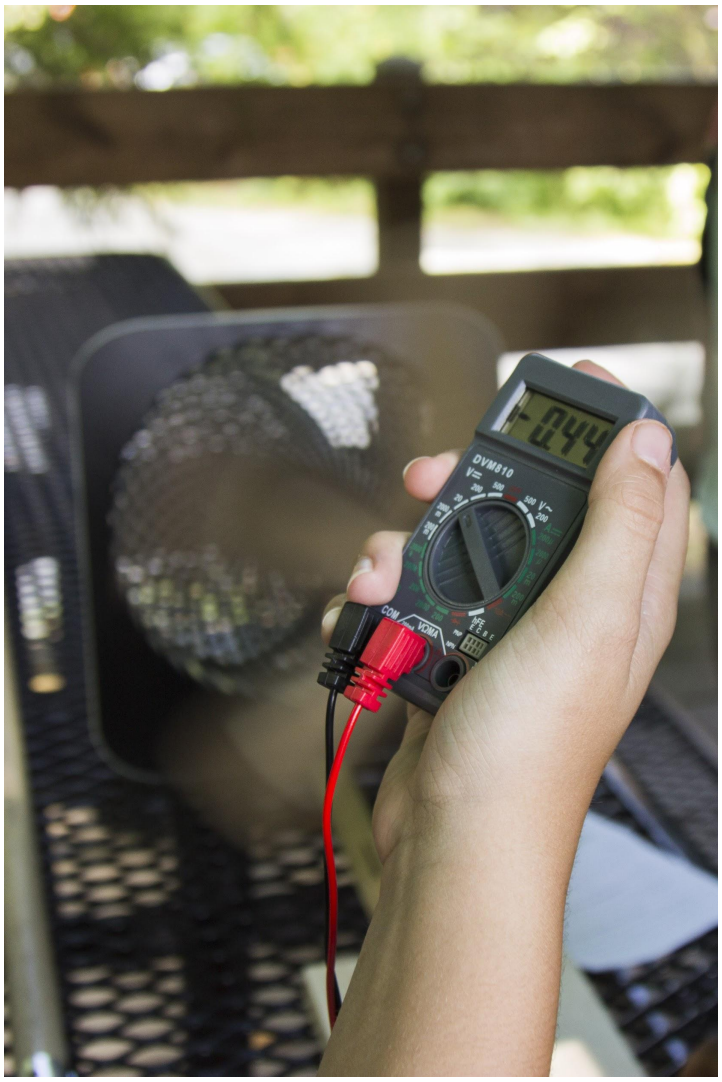

SUSTAINABILITY

Assessing Human Impact on Natural Resources

Bridging the Watershed

Bridging the Watershed is an outreach program of the Alice Ferguson Foundation, in partnership with the National Park Service and area schools, which offers secondary school students opportunities to study real-world science in national parks. Its purpose is to promote student academic achievement, personal connections with the natural world, lifelong civic engagement, and environmental stewardship through hands-on, curriculum-based, outdoor studies in national parks and public lands.

Many thanks go to the Alice Ferguson Foundation, National Park Service, and Prince George's County Public Schools, who have provided in-kind and financial support to foster the development and sustainability of the BTW program. The BTW administrative office is based at the Alice Ferguson Foundation, a 330-acre environmental center on the Potomac within Piscataway Park—10 miles downstream from Washington, D.C

ACKNOWLEDGEMENTS

SPECIAL RECOGNITION
The Bridging the Watershed (BTW) partners wish to thank Siemens Industries and the National Park Foundation for funding this project to provide secondary students the opportunity to study real-world science within our national parks.

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Sustainability: Assessing Human Impact on Natural Resources

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An Overview of the Bridging the Watershed Program

Bridging the Watershed is an environmental education program for secondary school students designed to promote understanding and stewardship of the Potomac watershed. The program, the product of a partnership among twelve national parks within the National Capital Region, two school districts in the Potomac River basin, and countless schools throughout the region, uses national parks as outdoor learning laboratories. Part of every module is a field study in one of these national parks, where students use the processes of science to learn about the health of the natural resources in the Potomac watershed. These processes include analyzing the water quality of streams, identifying benthic macroinvertebrates, assessing runoff and suspended sediment in waterways, quantifying the kinds of trash found in the watershed, and conducting surveys of alien and native plants to discover the impact of human activity.

One of the main goals of the BTW program is to make the activities relevant to students' lives, serving to bridge the divide between science in the classroom and science in the natural world. Many students have had little or no contact with the natural environment or with national parks. This program aims to provide students with exposure to science in a natural setting, broadening their understanding of scientific study. The activities are based on sound pedagogical principles and correlated to national, state, and local education standards. As a result, the activities in all modules are inquiry-based and "hands-on/minds-on," encouraging students to experiment and then draw conclusions based on the results of the experiments. The program follows the constructivist pedagogy and uses the 5 E's of the teaching/learning cycle—Engage, Explore, Explain, Elaborate, and Evaluate—as its structure. All activities are student-directed, with the teacher acting as the guide and facilitator.

Each of the modules focuses on a particular discipline of science: chemistry, biology, earth science, or environmental science. Nonetheless, the activities are interdisciplinary with a major emphasis on science. While each module is meant to stand alone and be used primarily in the science class on which it focuses, teachers may find it helpful to use more than one module with their students. All modules contain pre-field study activities and preparation, a one-day field study in a national park, and follow-up analysis and reflection on the experience. At the conclusion of each module, students are encouraged to engage in a service project during which they can apply what they have learned about the environment to their own community or in a national park.

The Core Modules in the BTW Curriculum: The following summaries describe the core modules in the BTW curriculum. Included in the summary is the science discipline or disciplines to which the module is most closely related.

Watershed Watchdogs: Assessing Water Quality Chemistry or environmental science students study nine parameters that will help them determine the Water Quality Index (WQI) for the Potomac River or one of its tributaries.

Water Canaries: Assessing Benthic Macroinvertebrates: Students in biology or environmental science classes learn to identify benthic macroinvertebrates and then determine water quality by using the sensitivity ratings for the macroinvertebrates found in the stream during their field study.

Exotic Invaders: Assessing Exotic Invasive Species: Biology and environmental science students study the importance of biodiversity, learn the basics of plant identification, and explore the extent of alien plant invasion in a local national park.

Don't Get Sedimental: Runoff and Sediment in the River: Students in Earth science or environmental education classes explore the impact that runoff from increasing development has on the watershed.

Talkin' Trash: Make a Litter Difference: Students in environmental science and statistics classes examine the impact of trash in their watershed. They learn how trash reveals a lot about the lifestyle of the residents that create it, how trash impacts the environment, what to do with all the trash we produce, and how personal choices can make a difference.

Sustainability: Assessing Human Impact on Natural Resources: Students in environmental science classes learn how to minimize human impacts on the environment by exploring natural resources and determining how a park, school, and home use natural resources.

The Park Specific Modules in the BTW Curriculum: Each park that is affiliated with BTW has unique characteristics. Certain parks, because of their special cultural or natural resources, have a curricular module designed explicitly for that park. The following summaries describe the park specific modules in the BTW curriculum. Included in the summary are disciplines to which the module is most closely related.

Battle to Save Water Quality (Monocacy National Battlefield): Evaluating best management practices to preserve water quality on farmland The battle that saved Washington,D.C. from Confederate capture was, and is to this day, on farmland. Environmental science, agriculture, or general science students explore how farmers, past and present, play an important role in water quality stewardship of the Monocacy River and its tributaries.

Herring Highway (Rock Creek National Park): Studying the habitat and annual migration of herring Rock Creeks' fish inhabitants and human beings have been interdependent for thousands of years. Today, the survival of the fish is dependent upon human behavior more so than ever. Environmental science or biology students investigate how environments may be altered by humans and can be altered again to accommodate wildlife.

Mine Over Matter (Prince William Forest Park): Impact of the abrupt shut down of the Cabin Branch Pyrite Mine in 1920 that continues today Environmental science, chemistry, history, or general science students search out the relationship between minerals and human wealth. The module allows them to see how freshwater resources are influenced

by geologic processes and human activity. It gives students an opportunity to see how decisions made nearly 100 years ago continue to impact quality of life today.

Urban Pools (The National Mall & Memorial Parks): Exploration of the management of abiotic and cultural components of urban water features Not all bodies of water are created by nature; some are human-constructed with a purpose in mind. Students compare the chemical parameters of various bodies of water within The National Mall & Memorial Parks to contrast how their intended uses affects the chemical parameters.

Water Power (Harpers Ferry National Historical Park): The confluence of human economic activity and natural ecological impacts The physical and historical geography of the Harpers Ferry area demonstrates to environmental science, general science, or history students how landscapes shape human history and how human endeavors profoundly affect natural landscapes—a powerful reminder that the actions of today determine the opportunities of tomorrow.

Additional Components of the BTW Program: The program also offers professional development for teachers and a website with additional activities.

Teacher/Ranger Workshops and Institutes: Held at participating national parks, teachers and park rangers become trained in the BTW program and explore the modules in depth. Teacher and ranger workshops are generally one or two day events for targeted audiences. Workshops can be introductions to the program, enrichments of professional knowledge, or a combination of both.

Institutes, the capstone of BTW training, are held every summer for 3 days and are unlike any other training. Teachers learn in parks as outdoor laboratories, performing the field science their students will do. They work hand-in-hand with knowledgeable park rangers to experience our region's natural and cultural wonders. Often participating teachers receive extra benefits from attending a BTW institute.

BTW Website: The interactive website, found at http://www.fergusonfoundation.org/bridging-the-watershed, provides an essential link to enrich and reinforce the educational experience of the program. Teachers and rangers can find online activities to prepare for a visit to the parks, gain valuable knowledge about parks and their natural resources, or subscribe to receive updates on time-sensitive grants, trainings, awards, and news. Students' results of their field study can be uploaded to a database, making the web site a valuable community resource of watershed data. Teacher opportunity pages provide information about upcoming events, workshops, and the annual BTW institute.

A Constructivist Approach: Bridging the Watershed Activities

It sounds like a simple proposition: we construct our own understandings of the world in which we live. We search for tools to help us understand our experiences. To do so is human nature. Our experiences lead us to conclude that some people are generous and other people are cheap of spirit, that representational government either works or doesn't, that fire burns us if we get too close, that rubber balls usually bounce, that most people enjoy compliments, and that cubes have six sides. These are some of the hundreds of thousands of understandings, some more complex than others, that we construct through reflection upon our interactions with objects and ideas.

Each of us makes sense of our world by synthesizing new experiences into what we have previously come to understand. Often, we encounter an object, an idea, a relationship, or a phenomenon that doesn't quite make sense to us. When confronted with such initially discrepant data or perceptions, we either interpret what we see to conform to our present set of rules for explaining and ordering our world, or we generate a new set of rules that better accounts for what we perceive to be occurring. Either way, our perceptions and rules are constantly engaged in a grand dance that shapes our understanding.

Consider, for example, a young girl whose only experiences with water have been in a bathtub and a swimming pool. She experiences water as calm, moving only in response to the movements she makes. Now think of this same child's first encounter with an ocean beach. She experiences the waves swelling and crashing onto the shore, whitecaps appearing then suddenly vanishing, and the ocean itself rolling and pitching in a regular rhythm. When some of the water seeps into her mouth, the taste is entirely different from her prior experiences with the taste of water. She is confronted with a different experience of water, one that does not conform to her prior understanding. She must either actively construct a different understanding of water to accommodate her new experiences or ignore the new information and retain her original understanding. This, according to Piaget and Inhelder (1971), occurs because knowledge comes neither from the subject nor from the object, but from the unity of the two. In this instance, the interactions of the child with the water, and the child's reflections on those interactions, will in all likelihood lead to structural changes in the way she thinks about water…

As human beings, we experience various aspects of the world, such as the beach, at different periods of development, and are thus able to construct more complex understandings. The young child in this example now knows that the taste of seawater is unpleasant. As she grows, she might understand that it tastes salty. As a teenager, she might understand the chemical concept of salinity. At some point in her development, she might examine how salt solutions conduct electricity or how the power of the tides can be harnessed as a source of usable energy. Each of these understandings will result from increased complexity in her thinking. Each

new construction will depend upon her cognitive abilities to accommodate discrepant data and perceptions and her fund of experiences at the time.

—Excerpted from The Case for Constructivist Classrooms
by Jacqueline Brooks and Martin Brooks

The activities in this module use a constructivist, interdisciplinary approach. Students construct their own knowledge of the science underlying the problems/issues they explore. Activities include active discussions, writing, research, and the use of the scientific method to observe and gather authentic data. Students observe problems in the watershed in which they live from a historical perspective, from the perspective of being a member of the human community, and from the perspective of an environmental scientist. Working in cooperative groups, and at times individually, students work on activities that include engaging questions and situations. They are guided through field and laboratory explorations that invite them to hypothesize about what will happen, to interact with natural phenomena, to observe, and to collect data about their observations. They will test their theories, explain results, and decide whether to keep or abandon their theories.

The teacher's role is to help students express their preconceptions about the problems and ideas presented in this module. After conducting the hands-on investigations, students are provided with opportunities to modify any misconceptions. Data collection combined with class discussions about alternative theories will provide motivation for further exploration and will help students restructure their knowledge base. In the process, students gain confidence in their abilities to learn and understand science as well as gather useful scientific data about the watershed in which they live.

Several different models of instruction can help create a constructivist approach to learning. One model is based on the 5 E's (Engage, Explore, Explain, Elaborate, Evaluate), an instructional model in five phases. The phases, explained below, form the structure around which the activities and procedures are organized.

Engagement
This phase is designed to grab the student's interest. An object, situation, or problem that relates to the student's world is presented with an authentic question, a problem description, or an interactive scenario. The engagement is meant to lead the student to the task to come. The role of the teacher in this phase is to present the situation or problem and to identify the task. If this phase is successful, students are motivated to continue to the next phase: the exploration.

Exploration
Exploration activities are meant to provide students with concrete experiences, which they can build upon as they discover new concepts and learn new processes and skills. These activities bring answers and, if successful, satisfaction to the student. During the exploration phase, students need time to explore objects, events, or situations. They gather data to help them establish relationships, construct mental pictures, observe patterns, and question preconceptions. The teacher facilitates the exploration and coaches students from the sidelines. The teacher answers students' questions and helps them to begin restructuring their knowledge. At the end of this phase, students should be prepared to explain what they have discovered.
Explanation
This is the phase in which students should "see the light." The concepts, processes, and skills to which they have been exposed become clear. The learning is internalized. During the explanation phase, students and teachers agree on appropriate vocabulary to discuss the discoveries students have made. The teacher's role is to ask students to summarize what has happened in their own words. Then, the teacher begins to introduce scientific terms to describe the results. Explanation often provides order to the earlier phases and should lead quickly to the ability to elaborate on what has been learned.
Elaboration
This phase is designed to provide students with a chance to take what they have learned and extend or apply the concepts, processes, or skills to their lives. Often, elaboration activities are interdisciplinary and may involve writing, mathematics, or social studies. When students can clearly connect the early explorations with the explanations and the concepts with the observations, learning has been internalized. They are ready to evaluate their work.
Evaluation
Students need to receive feedback on whether their explanations have been adequate. Informal evaluations occur all during the learning task, but a more formal evaluation should occur after the elaboration phase. Students should evaluate their own work and understanding, as well as be evaluated by the teacher. Authentic assessment techniques can be employed to give students meaningful feedback on their individual work or any group work.

Module Overview

Sustainability Module Overview

Overview	Students will learn how to minimize human impacts on the environment by exploring natural resources and determining how a park, school, and home use natural resources. **Sustainability,** in this context, is the avoidance of the depletion of natural resources in order to maintain an ecological balance. “Though adapting to climate change is the core of National Park Service (NPS) strategy, it is far easier and more cost effective to prevent aspects of climate change from happening in the first place than to manage their effects. The NPS recognizes that many of our activities, decisions, and plans have impacts on greenhouse gas (GHG) emissions and storage. Therefore, responding to climate change begins with limiting our own emissions and incorporating climate-friendly practices into our management and culture” (NPS.gov).

Learning Objectives	After completing this module, students will be able to... ● Understand how humans interact with natural resources in their everyday life ● Understand individual impact of energy/water/waste choices ● The finite supply of nonrenewable resources, and the choices they can make to alleviate the energy problem ● Understand the differences between renewable and nonrenewable energy sources ● Understand how resources can be depleted over time ● Understand how sources of energy require an environmental impact ● Describe what National Parks are and the role of students/visitors in the work undertaken by the National Park Service (NPS) ● Understand the sustainability efforts taken by the NPS *National Capital Region* to mitigate human impact on natural resources ● Construct an argument to support utilization of community science, and new technology in sustainability efforts to lessen the impact of humans on natural resources ● Use the data collected at the field study to make recommendations to the parks on how to improve sustainability efforts in the following categories: energy generation potential, energy, consumer waste, water usage, and transportation ● Create a presentation either letter form or powerpoint to send the park rangers for the recommendations on improving sustainable efforts for the parks ● Analyze scoring of how sustainable the parks are by adding up the score for each of the categories ● Identify sustainable actions taken by administrations, teachers, and students ● Advocate for strategies and technologies that produce less pollution and waste

This module is divided into three sections: activities completed prior to the park visit (Pre-Field Studies), activities conducted in the park (Field Study), and activities completed subsequent to the park visit (Post-Field Studies). In the Pre-Field Study activities, students learn about ...Once in the park, students will have an opportunity to use the learned…. skills to …. In the context of collecting authentic data in the park, students gain a deeper understanding of the connection between the choices they make and the sustainability of natural resources in the micro and macro scale … When students return to the classroom, they will reflect on their visit to the park and summarize their recommendations… Students will also engage in an activity to understand how these issues are being addressed within their school community.

Sustainability Module Activities					
P	**Title**	**Objectives**	**Overview**	**Settings/Materials**	**Pages**
Pre-field Study Activities					
Engage	Sustainability Personal Inventory	Students will understand how humans interact with natural resources in their everyday life. Students will understand individual impact of energy/water/waste choices. Students will understand the finite supply of nonrenewable resources, and the choices they can make to alleviate the energy problem.	Students will take a personal inventory of the resources they use on a daily basis and then imagine their lives when those resources are unavailable. After evaluating their choices, they will take another inventory and see if their choices and impact were affected by education.		
	Energy Spoons	Students will understand the differences between renewable and nonrenewable energy sources. Students will understand how resources can be depleted over time. Students will understand how sources of energy require an environmental impact.	Using cards and a game of spoons students will learn about how energy gets to their home and how renewable sources of energy may provide alternatives to nonrenewable energy sources in the future.		
Field Study at a National Park					
Explore/ Explain	Park Sustainability Data Collection	Students will demonstrate understanding of the sustainability efforts taken by the National Park Service *National Capital Region* to mitigate human impact on natural resources.	Students will use the unique setting of a Park to assess sustainability measures and make recommendations to mitigate the impacts at public land use sites. They will use a survey to determine the impact of visitors to the park		

			in the areas of energy, water, waste, and transportation.		
	Solar Scavenger Hunt	Students will determine the variables that impact the effectiveness of renewable energy design.	Students will explore the park while measuring the solar capabilities of different sites using small panels.		
	Wind Turbine Engineering	Students will engage in science and engineering practices to develop an effective design	Students will work in groups to engineer multiple wind turbine designs in order to determine the most effective measures.		
	Park Recommendations		Students determine which area of concern the park they visited should focus on to make improvements		
Post-field Study Activities					
Explain	Letter Reflection	Students will use their data collected at the field study to make recommendations to the parks on how to improve sustainability efforts in the following categories: Energy generation potential, energy, consumer waste, and transportation. Students will create a presentation either letter form or powerpoint to send the park rangers for the recommendations on improving sustainable efforts for the parks	After field study students make recommendations on how to improve the park's sustainable efforts.		
	School Sustainability	Students will identify sustainable actions taken by administrations, teachers, and students. Students will advocate for strategies and technologies that produce less pollution and waste.	Students will assess the sustainability efforts of their school by making and recording observations pertaining to energy use, water use, waste, and transportation.		

Sustainability

Phase	Activity	Main Concept	Setting	Page
Engage	**Sustainability Personal Inventory**	Introduce/review natural resources and methods of use.	Individual, small groups	
	Energy Spoons	A card game reviewing renewable and non-renewable resources	Classroom, Small Group (groups of 4)	
Explore	**Sustainability Scavenger Hunt**	Assess park energy usage	Outdoors, Whole Class/Small groups	
	Sustainability: Solar Panel	Determine the optimal angle of inclination of solar panels and assess a desirable installation site	Outdoors, Small Group	
	Sustainability: Wind Turbine	Determine optimal fan blade shape, angle and number of blades to increase energy output	Outdoors or Indoors, Small group	
Explain	**Park recommendations**	Students determine which area of concern the park they visited should focus on to make improvements	Indoors or outdoors, Small Group	
Elaborate	**Letter to Park Service or Legislator**	Write a letter to address data collected, concerns and strategies for improvement	Indoor	
Evaluate	**School Energy Audit**	Students assess school usage and create a rating.	Indoor, small group, possible Internet/ computer	

Additional Resource for pre and during park visit:
Climate Change and Your National Parks
https://www.nps.gov/subjects/climatechange/index.htm

Next Generation Science Standards

Performance Expectations	
MS-ESS3-3	Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-ESS3-4	Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
MS-ETS1-2	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
HS-ESS3-4	Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
HS-ETS1-3	Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
HS-PS3-3	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
• **Asking Questions and Defining Problems** • **Analyzing and Interpreting Data** • **Using Mathematics and Computational Thinking** • **Constructing Explanations and Designing Solutions** • **Engaging in Argument from Evidence**	• **ESS3.A: Natural Resources** • **ESS3.C: Human Impacts on Earth Systems** • **ETS1.B: Developing Possible Solutions** • **ETS1.C: Optimizing the Design Solution** • **PS3.A: Definitions of Energy**	• **Cause and Effect** • **Systems and System Models** • **Stability and Change** - ***Connections to Engineering, Technology, and Applications of Science*** **Influence of Science, Engineering, and Technology on Society and the Natural World** - ***Connections to Nature of Science*** **Science is a Human Endeavor** **Science Addresses Questions About the Natural and Material World**

Pre-Field Study Activity

Engagement

Sustainability: Personal Inventory

Assessment starts at home

Overview:
Students will take a personal inventory of the resources they use on a daily basis and then imagine their lives when those resources are unavailable. After evaluating their choices, they will take another inventory and see if their choices and impact were affected by education.

Lesson Characteristics:
Use the table below for lesson planning purposes:

Time Required	40 minute class period + 20 minute follow up class period
Key Concepts/Terms	Renewable Resources Nonrenewable Resources
Setting	Classroom
Materials	● 2 worksheets for each student - ○ Sustainability Personal Inventory: Baseline ○ Sustainability Personal Inventory: Targeted Reduction ● Chart paper and markers

Next Generation Science Standards:
The activities outlined in this lesson are aligned with the following supporting Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts.

Performance Expectations		
MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment **MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.** **HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.**		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions	**ESS3.C: Human Impacts on Earth Systems**	**Cause and Effect** **Stability and Change**

Engaging in Argument from Evidence		

Learning Objectives:
Students will be able to …

- ...understand how humans interact with natural resources in their everyday life.
- ...understand individual impact of energy/water/waste choices.
- ...understand the finite supply of nonrenewable resources, and the choices they can make to alleviate the energy problem.

Preparation:
Students will complete the *Sustainability Personal Inventory: Baseline* worksheet as homework prior to this class.

Background Information:

With increased technology, consumption of energy continues to go up in the United States. Using natural, nonrenewable resources such as gas and coal to provide energy for individual needs like charging cell phones, turning on lights, transportation, cleaning water, and disposing of waste is depleting this supply far more quickly than it can be replenished. These nonrenewable resources cannot be replaced within the lifetime of the humans who consume them.

With this knowledge, the energy industry has begun to look to renewable energy sources that are infinite or easily replaced within the human lifespan, such as solar, wind, and hydropower. These resources contribute to a more sustainable system.

The transition from using a known technology of nonrenewable energy supply to using newer technologies that capture renewable energy is progressing, but, in the meantime, if individuals can identify ways to reduce their individual energy consumption (often called carbon footprint) this may lower the demand on the nonrenewable resources. The first way to make this reduction is to become aware of how much an individual uses and find ways to reduce this usage through efficiency or different choices.

Vocabulary:

Terms	**Definitions**
Carbon Footprint	Your carbon footprint is the amount of carbon dioxide and methane gas you release into the environment by consuming energy. Most energy produced in the world is done by burning fossil fuels.
Renewable Resources	Resources that can be used repeatedly because they can be replaced naturally over the average human lifespan.

Nonrenewable Resources	Resources that can not be readily replaced by natural means on a level equal to its consumption.
Sustainability	Avoidance of the depletion of natural resources in order to maintain an ecological balance

Procedure:
Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions for what an educator might say to students.** *Items in italics are possible student answers to questions.*

Step	Action	Teaching Notes
	Engage	
1	Students will have completed the *Sustainability Personal Inventory: Baseline* worksheet as homework. See Appendix page 66.	*Alternatively, the *Sustainability Personal Inventory: Baseline* worksheet could be completed in the classroom. In that case, give students a time frame in which to estimate their usage. For example, **Using this worksheet, think about what you used, starting from the dismissal bell yesterday to this moment. Think back and write down every time you used energy, water, transportation, or created waste.** Allow for peer correction when students under or overestimate their personal usage.
	Exploration	
2	**From your personal inventory, it should be clear how dependent we are on energy.** **Where does the energy we use come from?** Write down the sources. **Where do each of these come from?** *Coal is a fossil fuel mined from the ground then burned to create steam which turns a turbine to produce electricity.* *Natural Gas is a fossil fuel extracted from the ground*	

<table>
<tr><td></td><td>then burned to create steam which turns a turbine to produce electricity.
Oil is a fossil fuel extracted from the ground, and burned to create steam or hot exhaust gasses to turn a turbine to produce electricity.
Solar power is electricity produced by the sun’s radiation exciting an electron in a silicon panel.
Wind energy is electricity produced by wind turning a turbine.
Hydropower is the electricity produced by water turning a turbine.

What makes something renewable vs nonrenewable?
Clarify definitions (see vocabulary section) and then ask students to identify all of the sources you listed as either renewable or nonrenewable.

Note that at this time, most of our energy comes from nonrenewable sources that will run out at some point.</td><td>According to the US Energy Information Administration, in 2021, renewable energy sources only accounted for 12% of US energy consumption and 20% of US electric generation.

https://www.eia.gov/tools/faqs/faq.php?id=92&t=4</td></tr>
<tr><td colspan="3">Explanation</td></tr>
<tr><td>3</td><td>With increases in population and the resulting increases in demands on energy, the time at which those nonrenewable sources will run out is approaching more quickly.

Ask students: How would your life be different if the amount of energy available to you was dramatically different? What choices would you have to make? What could you do differently?</td><td rowspan="2"></td></tr>
<tr><td>4</td><td>Hang posters in four corners.Give them each one of the following titles: Energy Consumption, Transportation Emissions, Water Consumption, and Solid Waste. Each poster will then have a section for “24 Hour Usage” and “Reduction of Usage.” Example:

<table><tr><td colspan="2">Energy Consumption</td></tr><tr><td>24 Hour Usage</td><td>Reduction of Usage</td></tr></table>
Explain that these titles are the same four areas</td></tr>
</table>

	identified by the National Park Service for targeted reduction within the parks.	
5	Divide students into four groups and ask students to take their Personal Baseline Inventory sheet with them to join their group at one of the posters. Each group will estimate how much of each resource they used in 24 hours and write their amount under the 24 Hour Usage column. Each group will also brainstorm ways to reduce this amount and write these ideas in the Reduction of Usage column. Each group will have 5 minutes at each poster before switching to the next poster.	
Elaboration		
6	When all groups have completed the rotation, ask students to return to their seats and **consider what the other groups suggested for reduction of usage of resources**. Highlight some of the suggestions listed on the charts and write down new ideas that come from the group.	
7	**Can you make a personal reduction in resource usage in these four areas in the next 24 hours with sustainability in mind?** Help students make the connection that if they are able to make these choices, it would slow the demand for nonrenewable resources.	
8	Ask students to **identify large scale solutions to these resource reductions and write them down.** If changes were made on this scale, it would slow that demand even more. Hand out the *Sustainability Personal Inventory: Targeted Reduction* worksheet and ask the class to complete over the next 24 hours.	*Alternatively, ask the class to be mindful of their usage of resources over the next 24 hours and use the next class period to do the *Sustainability Personal Inventory: Targeted Reduction* with estimates from their memory of the last day.
Evaluation		
9	At the next class, have students bring the completed *Sustainability Personal Inventory: Targeted Reduction* worksheet to class and do the exercise again, just adding up the amount of resources they used in this 24 hour period. Have them compare the numbers from the first poster to see if usage went down.	

Pre-Field Study Activity

Engagement

Energy Spoons

To get power to your home

Overview:

Using cards and a game of spoons students will learn about how energy gets to their home and how renewable sources of energy may provide alternatives to nonrenewable energy sources in the future.

Lesson Characteristics:

Use the table below for lesson planning purposes:

Time Required	40-45 minutes
Key Concepts/Terms	Renewable, Nonrenewable, Turbine, Generator
Setting	Classroom, class divided into groups of four
Materials	● Set of cards per group ● Set of energy spoon placemats per group ● Worksheet for each student ● Four spoons per group

Next Generation Science Standards:

The activities outlined in this lesson are aligned with the following supporting Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts.

MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Constructing Explanations and Designing Solutions Engaging in Argument from Evidence	**ESS3.C: Human Impacts on Earth Systems**	**Cause and Effect Stability and Change**

Learning Objectives:

Students will be able to…

- ...understand the differences between renewable and nonrenewable energy sources.
- ...understand how resources can be depleted over time.
- ...understand how sources of energy require an environmental impact.

Preparation:

Print 1 deck of cards per group, placemats, and worksheets to make a class set. Set the classroom in a way for students to sit as groups of four.

Background Information:

We use electricity for a wide variety of activities in our daily lives. From our cell phones to our laundry machines they all require electricity to work. However, many people do not stop and ponder where their electricity comes from.

Electricity sources are categorized by: renewable and nonrenewable. Mostly, the electricity in the United States comes from nonrenewable sources: Natural Gas (33.8%) and Coal (30.4%). Whereas only 14.9% of our electricity comes from renewable sources (Hydropower, Wind, Biomass, Solar, and Geothermal).[1]

Nonrenewable resources are finite and cannot be replenished within a human's lifetime. These resources have taken thousands to millions of years to be produced and can be mined and burned within months. Eventually, we will run out of these resources.[2] Also, the environmental cost of the production and burning of these resources have caused harmful issues to our environment.

Renewable resources are infinite and use natural phenomena to produce energy. The environmental cost of the production and use of these resources is far fewer compared to the nonrenewable alternative.[3]

More information about different types of electricity and how it is transferred can be found here: https://shop.need.org/collections/secondary-guides/products/energy-infobooks

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Vocabulary:

Terms	**Definitions**
Coal	Coal is a fossil fuel mined from the ground then burned to create steam which turns a turbine to produce electricity

[1] https://www.eia.gov/tools/faqs/faq.php?id=427&t=3
[2] https://www.cia.gov/library/publications/the-world-factbook/geos/xx.html
[3] http://www.ucsusa.org/clean-energy/renewable-energy/environmental-impacts#.WSWR-2grK70

Biomass	Biomass are renewable energy sources that are burned to produce heat that produces steam to turn turbines and produce electricity
Hydroelectric	Rivers and creeks are dammed, the water then flows downhill within the dam through turbines that then generate electricity
Natural Gas	Natural Gas is a fossil fuel extracted from the ground then burned to create steam which turns a turbine to produce electricity
Nonrenewable Resources	Resources that take thousands to millions of years to be replenished
Nuclear	Utilizes the heat generated from the splitting uranium atoms to turn a turbine. Uranium is finite and is considered a nonrenewable source.
Renewable Resource	Resources that can be naturally replenished over a human's lifespan.
Solar Power	Electricity produced by the sun's radiation exciting an electron in a silicon panel
Wind Energy	Electricity produced by wind turning a turbine

Procedure:
Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions for what an educator might say to students.** *Items in italics are possible student answers to questions.*

Step	Action	Teaching Notes
Engage		
1	**What do we use that requires electricity?** *Cell phones, computers, cars, lights, washing machines, televisions, oven, refrigerator, tablets, etc.*	If students do not know any sources of electricity they can do research before continuing or could be told by the teacher.
2	**What are the sources of electricity to power the items we mentioned?** *By burning coal or natural gas. By harnessing the power of the sun, wind, water, or nuclear.* Create a list with two columns with one representing renewable and the other non-renewable. Make sure to correct any misunderstandings about these sources.	
3	**We know the sources of electricity and how the electricity is <u>used</u>. However, to determine if we can make a better system we need to understand the steps**	

	in between. Have students pick one source of electricity then map out the way the energy goes from source to use. Make sure to use the terms extract, transport, generate, and use. These terms are used in the activity. Make sure to map out both a renewable and a non-renewable source.	
4	**In this activity we are going to replicate the different electricity sources and how the sources we choose may need to change over time.**	
Explore/Explain		
5	Divide the class into groups of four and pass out the placemats. Each person should either have a renewable or non-renewable resource (if the class does not divide evenly make sure no group has more than four students). Pass out the worksheets.	Work through any questions the students may have about the game.
6	**One person per group read out loud the first part of the instructions for the game.** While the students are reading the instructions, pass out a deck of cards to each group. Once everyone has finished reading, have them fill out the first part of the worksheet. **Now read through what each card represents and begin the first round.** Allow students to finish through all rounds.	
7	**Fill out the rest of the worksheet.**	
Evaluate		
8	**Which energy source was able to make it through to the final round?** All groups will have a renewable resource at the end of the game. **Why did the renewable source of energy win out compared to the other options?** *There were fewer extract and transport cards. The renewable resources had less cards to have to get by the end of the game. Nonrenewable sources had to be extracted and transported more often.* Use the worksheet to evaluate the students' understanding.	
Elaborate		
9	**What happens in real life if we were to run out of nonrenewable sources of electricity?** *We have to rely on renewable resources.* Allow students to look at the different electricity sources that	

	are available at home. Provide different resources to show the environmental impacts of fossil fuels and renewable energy.	
Extensions		
10	Have students research whether or not renewable electricity can be used on the school grounds. Have students research ways to reduce the amount of electricity used at home or at school.	

Visit the Parks

Plan Wisely for Your Students' Field Study in the Park

Overview:
The information below will help students plan and prepare for their field study in a local national park.

Background Information:
It is crucial that all students be prepared for the field study in the park. For many students, working outdoors will be an unusual and challenging experience. You should review the information in this section carefully with your students to help them prepare mentally for the field study, and to ensure that they have the appropriate dress and supplies to be comfortable in the park. You may have to review this information several times before the park field study to be sure all students understand the required preparations and plan well for their visit. Listening to the weather and developing a what-to-wear list for the day is a great homework assignment or class discussion in advance of the field study. Some teachers do a dry run a few days in advance of the field study by having their students come to school wearing their field study clothes with their backpacks packed as if for the field study.

Before the site visit, complete the activities in this module to ensure that all students understand the concept of sustainability. Also, review the directions for data collection in this module. Students can read the resource information that provides the information they will use in the park.

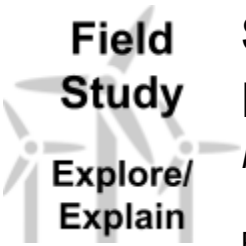
The AFF educator will have all the supplies for the field study activities.

Park Information:
Students can review information about the park on the Alice Ferguson Foundation website: www.fergusonfoundation.org or visit the specific park's website to learn about the park and its history.

Things to Bring:
- There will be no place to buy food. Students must bring a bag lunch and plenty to drink, preferably water.
- The hotter the weather, the more students should bring to drink. Have students pack their lunch and drinks in a backpack or bag that they can easily carry into and out of the park study site.
- Keeping in the ecology-minded spirit, suggest that students make their lunch as trash free as possible. Some areas and parks have no trash cans. What is packed in must be packed out.
- Make sure that students bring sunscreen and insect repellant.

Park Stewardship:
- Remind students that no collecting of any type is permitted.
- Remind students to take only photographs and leave only footprints.

Tips About Clothing:
- Students should wear comfortable clothing that allows them to easily move, hike, bend, and climb. Students may have to gather data in a wet and muddy environment, so they should choose clothes they don't mind getting wet and dirty.
- Dress for the weather. In cool weather, encourage students to wear layers of clothing to keep them warm in the early morning, but that they can remove later in the day or while working. If the forecast calls for possible rain, students should wear a waterproof jacket, hat, and shoes, and bring a plastic bag for materials.
- Students should wear pants even in the warm weather as they may be walking in tall grass.



Sustainability: Assessing Human Impact on Natural Resources

Field study information for the BTW Educator

Park Data Collection and Solutions

Overview:
Students will use the unique setting of a State or National Park to collect data on sustainability measures and make recommendations to mitigate the impacts at public land use sites. They will prospect for available natural energy at sites within the field experience boundaries.

Lesson Characteristics:
Use the table below for lesson planning purposes:

Time Required	3-4 Hours
Key Concepts/Terms	Place Based Learning Sustainability
Setting	Park Sites
Materials	● Data Sheets ● Pre-Survey/ Post-Survey ● Pencils ● Park Data Cards ● Teacher Data Sheet Solar Scavenger Hunt: ● Solar Testing Kit (solar panel, protractor, instructions & voltmeter) Wind Energy Engineering: ● Fan ● Ruler ● Wind Turbine Kit (base, nacelle, tower, blades, hub, voltmeter, instructions & protractor) Park Sustainability Data Collection: ● Cards with Vocabulary Terms

Next Generation Science Standards:
The activities outlined in this lesson are aligned with the following supporting Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts.

MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine

how well they meet the criteria and constraints of the problem. **MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.** **HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.** **HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.** **HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.**

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions **Engaging in Argument from Evidence**	**ESS3.A: Natural Resources** **ESS3.C: Human Impacts on Earth Systems** **ETS1.A: Defining and Delimiting an Engineering Problem** **ETS1.B: Developing Possible Solutions**	**Energy and Matter** **Influence of Science, Engineering, and Technology on Society and the Natural World**

Learning Objectives:
Students will be able to…

- ...describe what National Parks are and the role of students/visitors in the work undertaken by NPS.
- ...demonstrate understanding of the sustainability efforts taken by the National Park Service *National Capital Region* to mitigate human impact on natural resources.
- ….construct an argument to support utilization of community, science, and new technology in sustainability efforts to lessen the impact of humans on natural resources.
- ...understand design principles related to sustainability.

Preparation:

Before students arrive, prepare all materials and check-in with the assigned park ranger.

Review information about Solar and Wind energy to understand more information about renewable energy before the field study.

Background Information:

During the field study, students will work in small groups to explore a local State or National Park to observe sustainability efforts, engineer wind turbines and determine the applicability of solar panels at the site.

Each park in the National Capital Region created an action plan that is relative to their

individual Sustainability Efforts. Each pdf created by the parks can be found below.

- Antietam National Battlefield Climate Action Plan: https://www.nps.gov/subjects/climatechange/upload/ANTI-CFP-Action-Plan-508compliant.pdf
- Catoctin Mountain Park Climate Action Plan: https://www.nps.gov/subjects/climatechange/upload/CATO-CFP-Action-Plan-508compliant.pdf
- Chesapeake and Ohio Canal National Historic Park Climate Action Plan: https://www.nps.gov/subjects/climatechange/upload/CHOH-CFP-Action-Plan-508compliant.pdf
- George Washington Memorial Parkway Climate Action Plan: https://www.nps.gov/subjects/climatechange/upload/GWMP-CFP-Action-Plan-508Compliant.pdf
- Harpers Ferry National Historical Park Climate Action Plan: https://www.nps.gov/subjects/climatechange/upload/HAFE-CFP-Action-Plan-508compliant.pdf
- Manassas National Battlefield Park Climate Action Plan: https://www.nps.gov/subjects/climatechange/upload/MANA-CFP-Action-Plan-508compliant.pdf
- Monocacy National Battlefield Climate Action Plan: https://www.nps.gov/subjects/climatechange/upload/MONO-CFP-Action-Plan-508compliant.pdf
- National Capital Parks – East Climate Action Plan: https://www.nps.gov/subjects/climatechange/upload/NACE-Final-Action-Plan-7-11-11.pdf
- Prince William Forest Park Climate Action Plan: https://www.nps.gov/subjects/climatechange/upload/PRWI-CFP-Action-Plan-508compliant.pdf
- Richmond National Battlefield Park Climate Friendly Parks Action Plan: https://www.nps.gov/subjects/climatechange/upload/RICH-CFP-Action-Plan-508compliant.pdf
- Rock Creek Park Climate Action Plan: https://www.nps.gov/subjects/climatechange/upload/ROCR-CFP-Action-Plan-508compliant.pdf

More information about wind and solar energy can be found here:

- Wind: https://www.need.org/Files/curriculum/infobook/WindS.pdf
- Solar: https://www.need.org/Files/curriculum/infobook/SolarS.pdf

*Additional knowledge of the Park's cultural and/or historical message should be used to tie together the history of natural resource usage to the present level of consumption and future sustainability efforts. This will be the role of the park ranger. However, it may be up to the educator to make the past, present, and future connection.

Vocabulary:

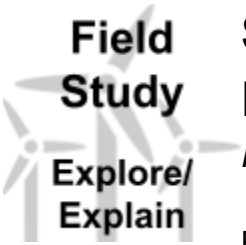
Terms	Definitions
Sustainability	avoidance of the depletion of natural resources in order to maintain an ecological balance.
Place Based Education/ Learning	refers to a wide variety of instructional methods and programs that educators use to connect what is being taught in schools to their surrounding communities, including local institutions, history, literature, cultural heritage, and natural environments.

Procedure:
Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions for what an educator might say to students.** *Items in italics are possible student answers to questions.*

Step	Action	Teaching Notes
Engage		
1	When students arrive at the site for the field experience, allow time for unloading and bathrooms.	
2	Have students complete the pre-survey. Have the teacher complete the teacher data sheet.	
3	*If the ranger is not present:* Introduce the students to the park and its history. Explain to students the purpose of the National Park Service and the role of the students/visitors. Briefly describe the Sustainability Efforts being undertaken by this park.	
4	**Every day, we use natural resources in many ways. As individuals, this usage may not seem like much, but it adds up when you consider an entire population. In 2016, the [Jefferson Memorial saw 3,414,345 visitors]. That's over [3 Million] people using transportation and energy to get to the memorial, generating waste while visiting, and most likely, utilizing water before, during, and after their trip.** Highlight for students that sustainability efforts being undertaken by the park and resource usage in general can be very roughly broken down into four categories: waste, water, energy, and transportation.	Will be different for each park. See the park cards for more information.
5	Use this time to gauge students' understanding of resource usage, human impact, and sustainable practices around the four general categories.	

Explore		
6	Divide students into groups of 3-5 and pass out data sheets. **Fill out the first page of your data sheet.** **On page 8 we will determine an estimate for the potential resource usage by the visitors who came here in 2016. As was mentioned earlier today this park saw _____ visitors, work with your group on page 8 to estimate their potential resource usage.** **What were some things you noticed about the results? Parks are doing their parts to help cut down some of the natural resource usage by their patrons. Today, we are going to observe and record some of these changes.**	Students may want to use cell phones to determine weather for the day. Students may want to use cell phones to calculate usage. Allow for comments even if the statements are misunderstood.
7	**With your group walk around the park and building(s) recording the sustainability efforts in the areas of Energy, Waste, Water, and Transportation. Suggestions are provided within each area of observation, however, you may decide as a group the score that is observed is different from the suggestions. Items with an asterisk may require information from a park ranger. Record your results on page 4 and 5 of your data sheets.** Pass out vocabulary picture cards that groups can utilize if they do not know the terms.	Make sure to set boundaries, and a time and location to meet back together The entire group can be split in half so one half is doing the park sustainability data collection and solar panel portions while the other half is doing the wind portion.
8	Once the groups come back, pass out the Solar Scavenger Hunt boxes. **Go around to different areas to find the best site a park could put solar panels. On page 2 of your data sheet you will record the location, time, and description of this location that could affect solar harvesting there. Each Solar Scavenger Hunt box has directions on how to determine the amount of electricity the area could produce. Once your group is finished with the three areas, come back to the starting spot.**	Make sure to set boundaries. The Solar Scavenger Hunt directions are in the appendix on page .
9	When all the groups have had the opportunity to measure the solar energy in three different areas, bring them together. **Now, we are going to try out wind engineering.** Pass out the wind engineering kits. **Inside each kit are instructions on how to engineer your wind turbine. Your group will have three trials to convert as much wind energy from a fan into electricity. With your best**	There are two fans for groups to test their wind turbines. After a group has tested they should give time for another group to try. The Wind Engineering directions are in the appendix on page .

	design, attempt to harness electricity from the wind at the study site.	
Explain		
10	Bring the group together for a conclusion. This time will be used to discuss what the students found out while completing the wind turbine engineering and solar scavenger hunt portions of the field study. The Ranger can provide more insight as to why certain suggestions could work and certain suggestions cannot. **What were some things you noticed when you changed the angles of the solar panels? Changed the blades on the turbine?** **Of the three locations, where did you notice you were able to convert the most solar energy into electricity? Would/could you put solar panels at this location? Why or why not?** **Was there another location your group noticed that would be better for solar panels that you all couldn't access.** **What did your group determine to be the optimal wind turbine? Were you successful in harnessing wind from the park?** **Why/Why not was your design successful in creating electricity from the wind at the study site?** **How would utilizing solar panels or wind turbines reduce impacts of human activities on natural systems in this park?**	These are not all the questions you could ask the group. The conclusion is for the students to understand that there may be locations where solar panels or wind turbines would not belong.
Evaluate		
11	This time will be used to evaluate students' understanding of the 4 categories the parks are focusing on to lessen their impact on natural resources. **What were some efforts the park is utilizing to lower their impact on natural systems your group observed? Of the 4 categories which does it fall into?** **Were there any efforts the park is utilizing that surprised your group?**	If there is time students can complete pages 6 and 7: park recommendations. Otherwise this can be done in class
12	Administer the post-survey to all students.	



Sustainability: Assessing Human Impact on Natural Resources

Field study information for the Teacher

Park Data Collection and Solutions

Overview:
Students will use the unique setting of a National Park to collect data on sustainability measures and make recommendations to mitigate the impacts at public land use sites. They will prospect for available natural energy at sites within the field experience boundaries.

Lesson Characteristics:
Use the table below for lesson planning purposes:

Time Required	3-4 Hours
Key Concepts/Terms	Place Based Learning Sustainability
Setting	Park Sites
Materials	• Student Medications • Lunches (if students do not bring their own)

Next Generation Science Standards:
The activities outlined in this lesson are aligned with the following supporting Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts.

MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts

Constructing Explanations and Designing Solutions **Engaging in Argument from Evidence**	**ESS3.A: Natural Resources** **ESS3.C: Human Impacts on Earth Systems** **ETS1.A: Defining and Delimiting an Engineering Problem** **ETS1.B: Developing Possible Solutions**	**Energy and Matter** **Influence of Science, Engineering, and Technology on Society and the Natural World**

Learning Objectives:

Students will be able to…

- ...describe what National Parks are and the role of students/visitors in the work undertaken by NPS.
- ...demonstrate understanding of the sustainability efforts taken by the National Park Service *National Capital Region* to mitigate human impact on natural resources.
- ….construct an argument to support utilization of community, science, and new technology in sustainability efforts to lessen the impact of humans on natural resources.
- ...understand design principles related to sustainability.

Preparation:

Schedule the field study at: http://fergusonfoundation.org/bridging-the-watershed/schedule-a-field-study/ making sure to follow the 5 easy steps. Have students participate in the Pre-field study activities that are listed elsewhere in this document. Read through and participate in the Visit the Parks section of this module with your students. Communicate with the educator about expectations of the field study prior to arriving.

Review information about Solar and Wind energy with students to expand their understanding before the field study.

Background Information:

During the field study, students will work in small groups to explore a local State or National Park to observe sustainability efforts, engineer wind turbines and determine the applicability of solar panels at the site.

Each National Park in the National Capital Region created an action plan that is relative to their individual Sustainability Efforts. Each pdf created by the parks can be found in the BTW Educator Field Study Background info: Pg. 31

More information about wind and solar energy can be found here:

- Wind: https://www.need.org/Files/curriculum/infobook/WindS.pdf
- Solar: https://www.need.org/Files/curriculum/infobook/SolarS.pdf

Additional knowledge of the park's cultural and/or historical message will be used to tie together the history of natural resource usage to the present level of consumption and future sustainability efforts. This will be the role of the BTW educator or park ranger.

Vocabulary:

Terms	**Definitions**
Sustainability	avoidance of the depletion of natural resources in order to maintain an ecological balance.
Place Based Education/ Learning	refers to a wide variety of instructional methods and programs that educators use to connect what is being taught in schools to their surrounding communities, including local institutions, history, literature, cultural heritage, and natural environments.

Procedure:
Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions for what an educator might say to students.** *Items in italics are possible student answers to questions.*

Step	Action	Teaching Notes
Engage		
1	When students arrive at the site for the field experience, allow time for unloading and bathrooms.	Please correct any behavioral issues that may come up throughout the field study.
2	The BTW educator will pass out pre-surveys to students and a teacher survey. Each survey will ask students for their gender and ethnicity. These questions are for continued funding for this program. Also, these questions are open ended and optional. No student is required to answer these questions.	
3	The Park Ranger and/or Educators will introduce the students to the park and its history. They will explain to students the purpose of the National Park Service and the role of the students/visitors. Briefly describe the Sustainability Efforts being undertaken by the National Parks.	
4	The educator will introduce the module and what will occur for the day. An exact write up can be found in the BTW educator field study document page 32.	
Explore		

5	Let the educator know if groups have already been divided. If not, the educator will divide the class into groups of 3-5 and provide each group with the data sheet. A copy of the data sheet is located on pages 81-84 in the appendix of this document. This data sheet will be taken back to the classroom to be reviewed. Educators will commonly say that this data sheet will be the students' grade for the day. The educator will review page 8 of the data sheet with students as a continuation of the introduction.	Students may want to use cell phones to determine weather for the day. Students may want to use cell phones to calculate usage.
6	During the park sustainability data collection students will make observations regarding the sustainability efforts in the areas of Energy, Waste, Water, and Transportation. It is vital for teachers and chaperones to move with the groups and provide assistance where necessary to keep students within boundaries and be back at the time mentioned by the educator. The groups are given vocabulary cards to help define certain indicators mentioned in the data sheet.	The entire group can be split in half so one half is doing the park sustainability data collection and solar panel portions while the other half is doing the wind portion.
7	Once the groups are done with the data collection or time is up, the groups will come back to the predetermined location. The educator will then pass out the Solar Scavenger Hunt boxes. Each Solar Scavenger Hunt box has directions on how to determine the amount of electricity the area could produce. The teacher and chaperones can help groups to interpret and understand the instructions.	The Solar Scavenger Hunt directions are in the appendix on page .
8	When the groups have completed the Solar Scavenger Hunt they will come back together. The educator will then pass out and introduce the Wind Engineering boxes. Each Wind Engineering box has directions on how to create a wind turbine which will convert the most amount of electricity. The teacher and chaperones can help groups to interpret and understand the instructions.	There are two fans for groups to test their wind turbines. After a group has tested they should give time for another group to try. The Wind Engineering directions are in the appendix on page .
Explain		
9	The BTW educator and Ranger will bring the group back together to conclude the field study. This will be a discussion from what the students found out while completing each part of the field study.	

Evaluate		
10	To evaluate the students' understanding from the field study the educator may ask: "What were some efforts the park is utilizing to lower their impact on natural systems your group observed? Were there any efforts the park is utilizing that surprised your group?"	If there is time students can complete pages 6 and 7 park recommendations. Otherwise this can be done in class
11	The BTW educator will administer the post-survey to all students.	

Field Study

Explore/ Explain

Sustainability: Assessing Human Impact on Natural Resources

Field study information for the Park Ranger

Park Data Collection and Solutions

Overview:
Students will use the unique setting of a National Park to collect data on sustainability measures and make recommendations to mitigate the impacts at public land use sites. They will prospect for available natural energy at sites within the field experience boundaries.

Lesson Characteristics:
Use the table below for lesson planning purposes:

Time Required	3-4 Hours
Key Concepts/Terms	Place Based Learning Sustainability
Setting	Park Site
Materials	*Note: For this module the BTW educator will be bringing the equipment. However, for the ranger it may help the students to bring pictures of sustainability measures they may not observe due to location constraints.*

Next Generation Science Standards:
The activities outlined in this lesson are aligned with the following supporting Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts.

MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.
HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Constructing Explanations and Designing Solutions **Engaging in Argument from Evidence**	**ESS3.A: Natural Resources** **ESS3.C: Human Impacts on Earth Systems** **ETS1.A: Defining and Delimiting an Engineering Problem** **ETS1.B: Developing Possible Solutions**	**Energy and Matter** **Influence of Science, Engineering, and Technology on Society and the Natural World**

Learning Objectives:

Students will be able to…

- ...describe what National Parks are and the role of students/visitors in the work undertaken by NPS.
- ...demonstrate understanding of the sustainability efforts taken by the National Park Service *National Capital Region* to mitigate human impact on natural resources.
- ….construct an argument to support utilization of community, science, and new technology in sustainability efforts to lessen the impact of humans on natural resources.
- ...understand design principles related to sustainability.

Preparation:

Before students arrive, prepare all materials and check-in with the assigned BTW Educator. Review the sustainability efforts taken by your individual park. Some of this information can be found below, but you may need to talk with other park staff to have a complete understanding.

Students will observe certain indicators throughout the park. These indicators can be found on page 83. Students are encouraged to ask rangers about some of these indicators.

Background Information:

During the field study, students will work in small groups to explore a local State or National Park to observe sustainability efforts, engineer wind turbines and determine the applicability of solar panels at the site.

Each National Park in the National Capital Region created an action plan that is relative to their individual Sustainability Efforts. Each pdf created by the parks can be found in the BTW Educator Field Study Background info: Pg. 31

*Additional knowledge of the Park's cultural and/or historical message will be used to tie

together the history of natural resource usage to the present level of consumption and future sustainability efforts.* This will be the role of the BTW educator or park ranger.

Vocabulary:

Terms	**Definitions**
Sustainability	avoidance of the depletion of natural resources in order to maintain an ecological balance.
Place Based Education/ Learning	refers to a wide variety of instructional methods and programs that educators use to connect what is being taught in schools to their surrounding communities, including local institutions, history, literature, cultural heritage, and natural environments.

Procedure:
Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions for what an educator might say to students.** *Items in italics are possible student answers to questions.*

Step	Action	Teaching Notes
Engage		
1	When students arrive at the site for the field experience, allow time for unloading and bathrooms.	
2	The BTW educator will pass out pre-surveys to students and provide a teacher survey.	
3	Introduce the students to the park and its history. Explain to students the purpose of the National Park Service and the role of the students/visitors. Briefly describe the Sustainability Efforts being undertaken by the National Capital Region.	
4	The educator will introduce the module and what will occur for the day. An exact write up can be found in the BTW educator field study document.	
Explore		
5	The group will be divided into groups of 3-5 and be provided with a data sheet. A copy of the data sheet is located on pages 81-84 in the appendix of this document. This data sheet will be taken back to the classroom to be	Students may want to use cell phones to determine weather for the day. Students may want

	reviewed. Educators will commonly say that this data sheet will be the students' grade for the day. This knowledge can keep students on task. The educator will review page 8 of the data sheet with students as a continuation of the introduction.	to use cell phones to calculate usage.
6	During the park sustainability data collection students will make observations regarding the sustainability efforts in the areas of Energy, Waste, Water, and Transportation. It is vital for rangers to assist in providing information on some indicators. The groups are given vocabulary cards to help define certain indicators mentioned on the data sheet.	The entire group can be split in half so one half is doing the park sustainability data collection and solar panel portions while the other half is doing the wind portion. The Solar Scavenger Hunt directions are in the appendix. There are two fans for groups to test their wind turbines. After a group has tested they should give time for another group to try. The Wind Engineering directions are in the appendix.
7	Once the groups are done with the data collection or time is up, the groups will come back to the predetermined location. The educator will then pass out the Solar Scavenger Hunt boxes. Each Solar Scavenger Hunt box has directions on how to determine the amount of electricity the area could produce. The ranger can help groups to interpret and understand the instructions.	
8	The groups will come back together after completing the Solar Scavenger Hunt. The educator will then pass out and introduce the Wind Engineering boxes. Each Wind Engineering box has directions on how to create a wind turbine to convert the most amount of electricity. The ranger can help groups interpret and understand the instructions.	
	Explain	
9	This time will be used to discuss what the students found out while completing the wind turbine engineering and solar scavenger hunt portions of the field study. The Ranger can provide more insight as to why certain suggestions could work and certain suggestions cannot. Example questions the educator or ranger could ask are: **What were some things you noticed when you changed the angles of the solar panels?** **Of the three locations, where did you notice you were able to convert the most solar energy into electricity?** **Would/could you put solar panels at this location? Why or why not?** **Was there another location your group noticed that**	For example: students may suggest placing solar panels on a historical site. The ranger can help provide insight as to why the site needs to be preserved.

	would be better for solar panels that you all couldn't access? **What did your group determine to be the optimal wind turbine?** **How would utilizing solar panels or wind turbines reduce impacts of human activities on natural systems in this park?**	
Evaluate		
10	To evaluate the students' understanding from the field study the educator may ask: "What were some efforts the park is utilizing to lower their impact on natural systems your group observed? Were there any efforts the park is utilizing that surprised your group?"	If there is time students can complete pages 6 and 7 park recommendations. Otherwise this can be done in class
11	The BTW educator will administer the post-survey to all students.	

Post-Field Study Activity

Elaborate

Letter Reflection

Student Recommendations to the Parks

Overview:
After the field study, students make recommendations to the National Park Service on how to improve the park's sustainable efforts.

Lesson Characteristics:
Use the table below for lesson planning purposes:

Time Required	1-2 hours
Key Concepts/Terms	Civic Engagement
Setting	Classroom
Materials	• Data Sheets from field study • Poster materials • Writing materials

Next Generation Science Standards:
The activities outlined in this lesson are aligned with the following supporting Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts.

MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.
MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
HS-ESS3-4 Scientists and engineers can make major contributions by developing technologies that produce less pollution and waste and that preclude ecosystem degradation.
HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data	**ESS3.C: Human Impacts on**	**Cause and Effect**

Constructing Explanations and Designing Solutions **Engaging in Argument from Evidence**	**Earth Systems** **ETS1.B: Developing Possible Solutions**	

Learning Objectives:
Students will be able to…

- ...use their data collected at the field study to make recommendations to the parks on how to improve sustainability efforts in the following categories: Energy generation potential, energy, consumer waste, water usage, and transportation.
- ….create a presentation in either letter form or powerpoint to send the park rangers for the recommendations on improving sustainable efforts for the parks.
- ...analyze scoring of how sustainable the parks are by adding up score for each of the categories.

Preparation:
Have the data sheets and maps of parks from the field studies in the classroom for this lesson.

Background Information:
Each of the National Parks has taken different efforts to make them more sustainable for the future.

Students research what the park is doing during the field study in different categories: Energy, Water, Waste, Transportation, and Energy generation potential and rate them based on how sustainable the practice is.

Vocabulary:

Terms	**Definitions**
Sustainability	avoidance of the depletion of natural resources in order to maintain an ecological balance.
Civic Engagement	Civic engagement refers to the ways in which citizens participate in the life of a community in order to improve conditions for others or to help shape the community's future.

Procedure:
Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions for what an educator might say to students.** *Items in italics are possible student answers to questions.*

Step	Action	Teaching Notes
	Engage	
1	In the same small groups as the field study, have students review the scores they assigned to the different categories of the park's Resource Consumption - Energy, Water, Waste, and Visitor Transportation (p. 4-5 of the data sheet).	
	Explore/Explain	
2	Have students from each group present how they rated the park in each category to the whole class and explain why they rated it that way.	
3	As a class, analyze each category, averaging the results of the field study observations and discussing any large discrepancies in scoring.	
4	Each group will choose a category to elaborate on resource consumption problems and to develop possible solutions. Focus should be on the area(s) with the worst ratings and how the park can improve. Using the information from the Energy Generation Potential (the Solar Scavenger Hunt and the Wind Energy Engineering) AND independent research on other solutions, students will map out recommendations for improvement on the park's existing sustainability efforts.	Whatever technology is available in your classroom can be used. Alternatively, this portion can be given as homework.
	Elaborate	
5	The groups present their recommendations to the class.	
	Evaluate	
6	The class will make recommendations to the park to improve their sustainability efforts, via powerpoint presentation, letter writing or video presentation. Send the presentation to AFF educators and park staff.	

Post-Field Study Activity

Evaluation

Sustainability: School Report Card

Grade Your School

Overview:
Students will assess the sustainability efforts of their school by making and recording observations pertaining to energy use, water use, waste, and transportation.

After calculating the sustainability score for their school students will analyze how the students, teachers, and administrators can improve the school sustainability score.

Lesson Characteristics:

Use the table below for lesson planning purposes:

Time Required	2-3 hours
Key Concepts/Terms	Renewable Nonrenewable
Setting	Classroom/Cafeteria/Parking Area/Bathroom
Materials	• Printed Scorecards for Energy/Waste/Water/Transportation • Pencils

Next Generation Science Standards:
The activities outlined in this lesson are aligned with the following supporting Science and Engineering Practices, the Disciplinary Core Ideas, and Crosscutting Concepts.

MS-ESS3-3 Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment. MS-ESS3-4 Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems. MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. HS-ESS3-4 Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.		
Science and Engineering Practices	**Disciplinary Core Ideas**	**Crosscutting Concepts**
Analyzing and Interpreting Data Constructing Explanations and	**ESS3.C: Human Impacts on Earth Systems**	**Cause and Effect Influence of Science,**

Designing Solutions Engaging in Argument from Evidence	ETS1.B: Developing Possible Solutions	Engineering, and Technology on Society and the Natural World

Learning Objectives:
Students will be able to …

- ...identify sustainable actions taken by administrations, teachers, and students.
- ...advocate for strategies and technologies that produce less pollution and waste.

Preparation:

Students may need to be escorted to make observations in cafeteria, schoolyard, and bathrooms.

Activity should not be performed during lunch hours, if possible.

Background Information:

“School buildings have an enormous impact on people and the environment. Globally, 1 in 8 individuals sets foot in a school every day.

Today, there are nearly 100,000 public schools in the U.S. with more on the horizon.

Schools manage a staggering 2 million acres of land and the equivalent of half the square footage of the entire commercial building sector. Standard building practices use and waste millions of tons of materials each year; green building uses fewer resources and minimizes waste. Green schools save energy and water to reduce utility costs for schools, and they protect the health and well-being of students and teachers.”

Sustainable products are an investment that may be more expensive to produce or purchase up front but can save money in the long run and reduce the consumption of non-renewable resources. For example, compostable lunch trays cost $0.049 apiece compared with $.04 apiece for the plastic trays. However, when composting is done right, it can save cities a lot of money. Sending trash to a landfill generally costs between $50 and $100 per ton on average. Composting, meanwhile, costs about $20 per ton on average. Also, trash may involve an additional transportation cost when it is transported to landfills across state borders.

Even without large amounts of capital to invest in supplies and projects, students can make a positive impact by simply making changes in behavior. Some schools have been successful in reducing energy use 20-37% through behavior strategies alone.

Sources:
http://centerforgreenschools.org/sites/default/files/resource-files/schools-info-sheet.pdf
http://www.npr.org/sections/thesalt/2015/06/06/411986584/schools-say-ciao-to-plastic-lunch-t

rays-hello-to-compostable-plates

Vocabulary:

Terms	Definitions
Biofuel	Biofuel is a renewable, biodegradable fuel manufactured domestically from vegetable oils, animal fats, or recycled restaurant grease.
CFL	(Compact Fluorescent Lamp) In CFL bulbs an electric current flows between electrodes at each end of a tube containing gasses. This reaction produces ultraviolet (UV) light which is transformed into visible light when it strikes a phosphor coating on the inside of the bulb.
Energy Star 	Energy Star qualified appliances incorporate advanced technologies and use 10 to 50 percent less energy than standard appliances.
Geothermal	Geothermal energy is heat derived below the earth's surface which can be harnessed to generate renewable energy. Small underground pathways conduct fluids through the hot rocks, carrying energy in the form of heat through wells to Earth's surface, driving turbines and generating electricity. (from U.S. Dept. Energy)
High Reflectance Roof	Made of light-colored materials, these roofs reflect a majority of sunlight away from the building as compared to traditional black roofs that absorb heat resulting in a reduction in energy needed to cool the building.
Hydropower	Hydropower technologies generate power by using a dam or diversion structure to alter the natural flow of a river or other body of water. (from U.S. Dept. Energy)
Incandescent	Incandescent bulbs produce light using electricity to heat a metal filament until it becomes "white" hot or is said to incandesce. As a result, incandescent bulbs release 90% of their energy as heat.
LED	(Light Emitting Diode) An electrical current passes through semiconductor material, which illuminates the tiny light sources we call LEDs.
Rain Barrel	A water tank used to collect and store rainwater runoff, typically from rooftops via rain gutters.
Single Stream Recycling	A system in which all paper fibers, plastics, metals, and other containers are mixed in a collection truck, instead of being sorted by

	the depositor into separate categories.

Procedure:

Students will work in four groups to make observations and collect data in four focus areas of the school (Bathroom, Cafeteria, Schoolyard/Parking, and Classroom). Assign students to one of the groups and provide them with the corresponding focus area worksheet. They will answer the questions only for their focus area by circling the correct response.

When students assemble back in the classroom they will share their numbered responses from their focus area with the class. The class will fill out one score page to create an overall sustainability score for the school.

Students will identify areas for improvement (water/waste/transportation/energy) and offer solutions to increase sustainability score.

Follow the steps in the table below to conduct the activity. **Sentences in bold are suggestions for what an educator might say to students.** *Items in italics are possible student answers to questions.*

Step	Action	Teaching Notes
Engage		
1	**Today you will work in four groups to make observations and collect data in four focus areas of the school (Bathroom, Cafeteria, Schoolyard/Parking, and Classroom).** **We will be using the resource usage categories that you learned about at the field study at the National Park: waste, water, energy, and transportation.**	
Explore/Explain		
2	Students will fill out their focus area worksheets.	
3	Now students will compile their data from the four categories to create a sustainability score. What was the sustainability score?	
Evaluate		
4	What are areas where the school can improve its sustainability score? *Answers will vary.*	

5	Think back to the field study: what were some of the reasons the National Park Rangers mentioned for changing to sustainable technology? (Or why do you think the parks changed to sustainable technology?) *To reduce greenhouse gasses.* *To improve visit experience.* *To create jobs.* *To save money.* *To set a positive example.* Would any of these be applicable to your school?	
Elaborate		
6	What are the behavioral changes that can be made (in other words if no money was available to invest in new technology what could you do to improve sustainability score)? *Turning off the lights when not in use.* *Riding bicycle to school.* *Creating club and signs to spread awareness.* How can investment in new technology be justified? Create an argument for new technology. *After initial investment, the technology overall in the long-term provides cost-saving benefits for the school.*	
Extensions		
7	Have students create an argument and presentation for administrators for using renewable energy or new sustainable technology at their school.	

Appendix:

Sustainability: Personal Inventory Worksheet
Baseline

Name _____

Date _____

For 24 hours, track your normal activities. Write down the duration and amount for each activity, every time it happens.

Transportation Emissions Write down every time you take the train, ride in a car, ride the bus. Make note of distances if you know them.

Time	Transportation Activity and Distance	Duration/ Frequency	Shared use?	With how many people?
7:35am	Example: bus ride to school, 4 miles	20 minutes	Yes	32 students
3:10pm	Example: car ride to work	15 minutes	No	

Add paper, if needed.

Solid Waste Write down a description of the items and the amount of anything you throw away. Do not count items you put in recycling or compost.

Time	Item thrown away to trash	Amount or weight	Shared use?	With how many people?
7:05am	Example: breakfast packaging	1	Yes	1
9:10am	Example: paper towels in bathroom	2 sheets	No	

Add paper, if needed.

Energy Consumption Write down every time you plug in your phone, turn on a light switch, use a microwave, etc. Also consider indirect energy use.

Time	Energy Consumption	Duration/ Frequency	Shared use?	With how many people?
11:00pm	Example: plug in cell phone charger	Overnight (7.5 hours)	No	
6:45am	Example: turn on lamp	15 minutes	No	

Add paper, if needed.

Water Consumption Write down every time you use water for anything – drinking, showering, washing dishes, cooking, washing cars, etc.

Time	**Water Consumed/Used**	**Approximate Amount**	**Shared use?**	**With how many people?**
6:50am	Example: flush toilet	1 standard flush	No	
6:55am	Example: shower	8 minutes	No	
7:15am	Example: drank water	1 glass	No	

Add paper, if needed.

Sustainability: Personal Inventory Worksheet
Targeted Reduction

Name _____

Date _____

For 24 hours, track your activities **while thinking about sustainability**. Write down the duration and amount for each activity, every time it happens.

Transportation Emissions How can you reduce your transportation emissions? What are you doing differently now? Write down every time you take the train, ride in a car, ride the bus, ride a bike, or walk (instead of driving). Make note of distances/time if you know them.

Time	Transportation Activity and Distance	Duration/ Frequency	Shared use?	With how many people?

Add paper, if needed.

Solid Waste How can you reduce your solid waste? What are you doing differently now? Write down a description of the items and the amount of anything you throw away. Also make note of trash that can be recycled or reused.

Time	Item thrown away to trash	Amount or weight	Shared use?	With how many people?

Add paper, if needed.

Energy Consumption How can you reduce your energy consumption? What are you doing differently now? Write down every time you plug in your phone, turn on a light switch, use a microwave etc.

Time	Energy Consumption	Duration/ Frequency	Shared use?	With how many people?

Add paper, if needed.

Water Consumption How can you reduce your water consumption? What are you doing differently now? Write down every time you use water for anything – drinking, showering, washing dishes, cooking, washing cars, etc.

Time	Water Consumed/Used	Approximate Amount	Shared use?	With how many people?

Add paper, if needed.

Energy Spoons Game Play

One person read aloud before playing:

The goal of this game is to get one of the spoons on the table. *Only when you have all the cards needed can you reach for a spoon.* Whoever is without a spoon will sit out the next round. We will play three rounds for an ultimate electricity winner.

Your teacher has given you a placemat with a spot for the four cards you need to get, and whether you are a renewable or nonrenewable source of electricity. Pick one electricity source your class brainstormed that coincides with whatever is on your placemat (ex. Renewable: Solar). Fill out the “before the game” part of your worksheet.

Energy Spoon Card Descriptions:

EXTRACT: Mining occurs to build materials for renewable power generators. Once mined the material is built into the generator. Once the generator is built they can last decades with proper upkeep and minor repairs.

Mining occurs to reach nonrenewable energy sources such as coal and natural gas. Once the material is burned to create electricity more material needs to be mined. These resources take thousands of years to replicate and once burned is gone forever.

TRANSPORT: Once mined the material to build renewable power generators is transported to wherever the generator is built then to wherever it is installed. Once installed the generator no longer needs to be transported.

The materials used for non-renewable power sources need to be transported to wherever it is burned to create electricity. In order to provide a consistent supply of electricity resources continually need to be transported. Also, once the material is transported the energy used to transport it is now lost and more energy is needed to continue the cycle.

GENERATE: Electricity from renewable resources is made by the force from phenomena generating electricity. The electricity generated goes down power lines to buildings.

Electricity from non-renewable resources such as coal and natural gas is made from the burning of these resources at a power plant. The burning heats up water which creates steam to turn a turbine attached to a generator. The electricity generated goes down power lines to buildings.

USE: The electricity generated can be used for everything from cell phones to washing machines.

Playing the game:

Round 1: Shuffle your deck of energy cards and place them next to whomever has the placemat with a star, this person is now “the dealer”, the pile of cards is the “Recycle” pile. The dealer starts by picking up a card from the pile, and placing it on the correct spot on their placemat. The dealer continues to draw cards; if they need it they place it on their mat, if they don’t need it they pass it to the person on their left. Each player passes to the person on their left if they don’t need that card. The last player places their passed cards into the “recycle” pile. Once you have the four cards you need, pick up a spoon. Once you have a spoon, continue to pass cards until all three spoons have been picked up. The electricity source that does not have a spoon sits out the next round.

Since more materials are needed for non-renewable sources of electricity place the **EXTRACT** and **TRANSPORT** cards from those placemats into a “Burn” pile they cannot be reused.

Since the generators have already been built for the renewable sources of electricity those players can keep their **EXTRACT** and **TRANSPORT** for the next round.

All other cards are placed back into the “Recycle” pile. This includes any cards received by the player who did not get a spoon.

Round 2: *Ten years later.* Shuffle your deck of energy cards and place it next to the dealer. Take one spoon and put it off to the side. Play another round.

Since more materials are needed for non-renewable sources of electricity place the **EXTRACT** and **TRANSPORT** cards from those placemats into a “Burn” pile they cannot be reused.

Since the generators have already been built for the renewable sources of electricity those players can keep their **EXTRACT** and **TRANSPORT** for the next round.

All other cards are placed back into the “Recycle” pile. This includes any cards received by the player who did not get a spoon.

Round 3: *Ten years later.* Shuffle your deck of energy cards and place it next to the dealer. Take one spoon and put it off to the side. Play the final round.

Energy Spoons

Using cards and a game of spoons you will model how electricity gets to your home and how certain sources may not be the best method of creating electricity in the future. Your group will play 3 rounds.

Before the game:

What is your Electricity Source?_____

Is your Electricity Source Renewable or Nonrenewable?_____

How many rounds do you think your Electricity Source can last?_____

After the game:

How many rounds did your Electricity Source last? _____

What Electricity Source lasted the longest? _____

Explain in your own words why the Electricity Source that lasted the longest was able to make it to the end?

_____

_____

_____

How does your answer above relate to how electricity is produced in real life?

_____

_____

_____

_____

_____

Why was it easier or more difficult for renewable electricity resources to outlast nonrenewables?

_____

_____

_____

_____

Extract

Extract

Extract

Extract

Generate

Generate

Generate

Generate

Generate

Generate

Generate

Generate

Transport

Transport

Transport

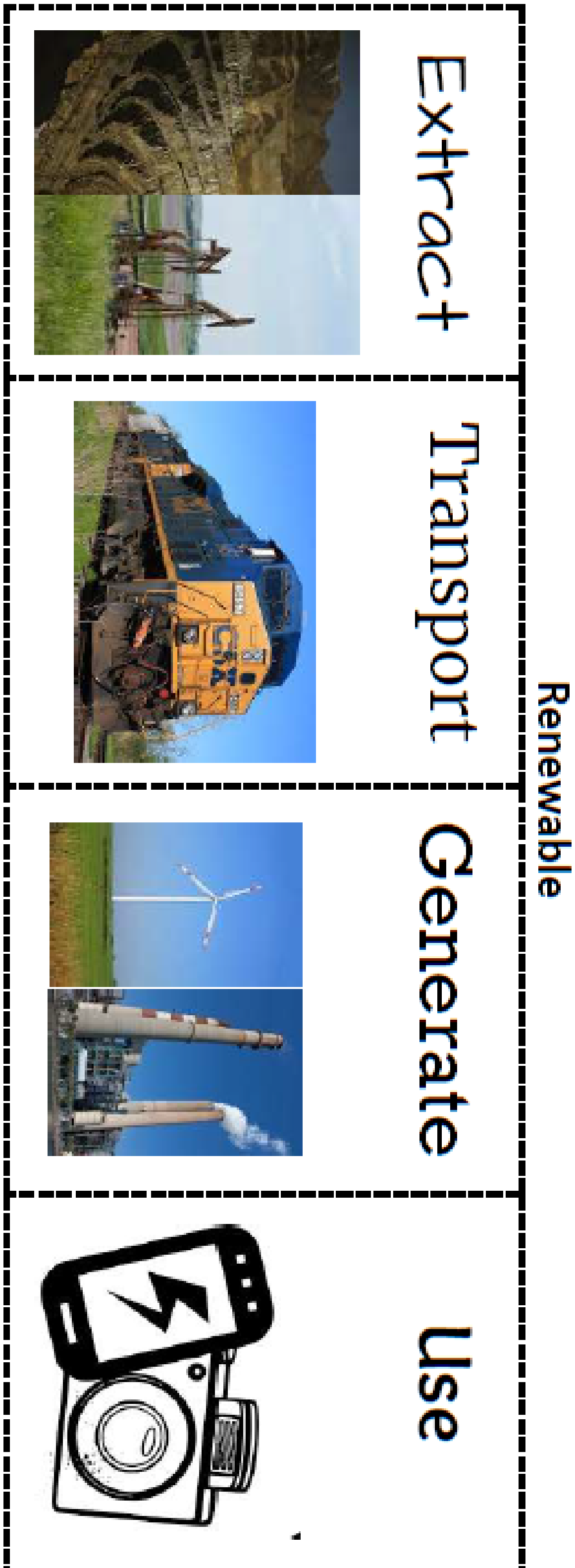
Transport

Transport

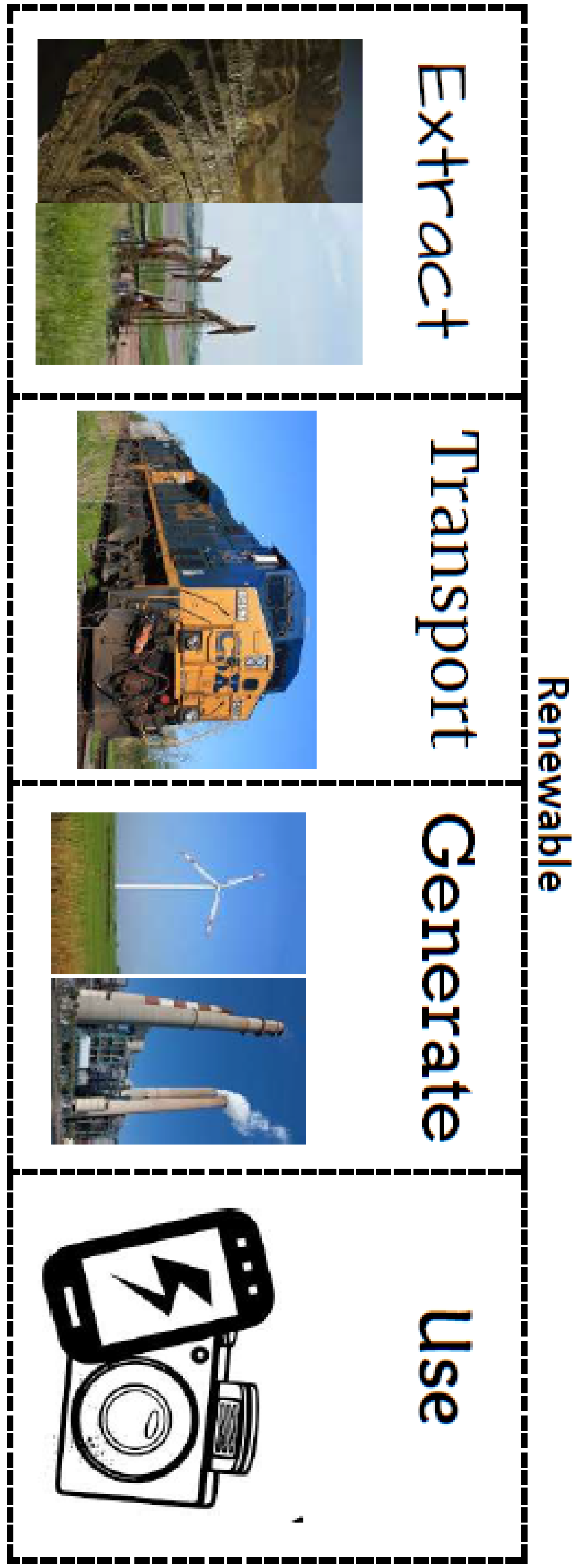
Transport

Transport 	Use 	Use 
Use 	Use 	Use 
Use 	Use 	Use 

Energy Spoons Placemats



Cut Here



Energy Spoons Placemats

★ Nonrenewable

Extract	Transport	Generate	Use
			

Cut Here

Nonrenewable

Extract	Transport	Generate	Use
			

Sustainability Data Sheet

Visitor Consumption

The Park by the Numbers

Each year, the National Park Service provides outdoor experiences for millions of visitors. Using the numbers for the park you are at today, determine an estimate for the potential resource usage by these visitors. Remember, this number is only a small fraction of what is taking place beyond the parks.

Park Name: _____

Number of Visitors in 2016: _____

(You may want to round up)

1. If each visitor flushes a toilet with a 3 gallon tank, how many gallons of water would be used? *(Visitors x 3)*_____
2. If each visitor flushes a toilet with a 1.6 gallon tank, how many gallons of water would be used?*(Visitors x 1.6)*_____
3. If every visitor arrived in a car with four people total, how many cars would have been driven to the park? *(Visitors/4)*_____
4. If every visitor arrived by bus, with 25 people per bus, how many buses would have been driven to the park? *(Visitors/25)*_____
5. If every visitor used two paper towels after using the restroom, how many paper towels would be used? *(Visitors x 2)*_____
6. It costs about one Kilowatt Hour or 12 cents, to charge a cell phone. How much would it cost for all of those visitors to charge their phones before visiting the park? *(Visitors x 0.12)*_____

Bridging the Watershed

Sustainability

Date:

Teacher:

Park:

Study Site:

Park Rangers & Educators: (one per row)

Group Members: (one per row)

	Yesterday			Today		
Air Temperature	____ °C			____ °C		
Cloud Cover	☐ Clear	☐ Partly Cloudy	☐ Cloudy	☐ Clear	☐ Partly Cloudy	☐ Cloudy
Precipitation	☐ None	☐ Rain	☐ Other	☐ None	☐ Rain	☐ Other

How could weather affect today's field study?

Bridging the Watershed • www.fergusonfoundation.org

Solar Scavenger Hunt

Renewable Energy

Complete the chart below as you hunt for the best site for solar energy at this park.

Location:	Time:		Trial 1	Trial 2	Trial 3
What impacts this location as a potential solar harvesting site? *[Examples: trees, clouds, historic site, pedestrian traffic]*		Angle of Panel:	0 (flat)	45	Optimal _____
		Volts: (Record Highest)			

Location:	Time:		Trial 1	Trial 2	Trial 3
What impacts this location as a potential solar harvesting site?		Angle of Panel:	0 (flat)	45	Optimal _____
		Volts: (Record Highest)			

Location:	Time:		Trial 1	Trial 2	Trial 3
What impacts this location as a potential solar harvesting site?		Angle of Panel:	0 (flat)	45	Optimal _____
		Volts: (Record Highest)			

What factors could impact the effectiveness of solar energy harvesting? Why?

_____

_____

_____

Water
Transportation

After completing your solar and wind tests, are either of these forms of energy a viable option for this park, and if so, where? Construct an argument based on evidence for why the park should pursue or not pursue this option.

_____

_____

_____

_____

Sustainability Data Sheet Continued

Park Recommendations

Now that you have observed the resource usage and sustainability status of the park, use this space to make recommendations to improve sustainability. You should draw or write your suggestions for each of the four areas.

On which area do you think the park should focus? Why?

_____

_____

Energy
Waste

Wind Energy Engineering

Renewable Energy

	Trial 1	Trial 2	Trial 3	Trial 4
# of Blades				
Blade Material				
Shape of Blades				
Angle of Blades				
Volts Generated				
Use the space below to describe/draw your most efficient design.				

How does your device "capture" the renewable energy source?

_____

_____

_____

What factors impacted the effectiveness of your design?

_____

_____

_____

Sustainability Data Sheet Continued

Park Sustainability

Sustainability Data Collection

Directions: As you visit the park, observe the sustainability efforts in the areas of Energy, Water, Waste, and Transportation. For each observation, decide on the score most closely reflects what you see or learn about the park's practices. Suggestions are provided within each area of observation, however, ***you may decide as a group the score that is deserved***. The indicators listed are suggestions only. Items with an asterisk(*) may require information from a Park Ranger.

		Indicators of Resource Consumption			
	Observations	(-1) High Consumption	(0) Minimal Impact	(+1) Sustainable	Score
Energy	Park Owned Vehicles	Mostly Gas-Powered	Some Hybrid/Electric	Electric Vehicles	
	Appliances*	No Energy Star Label		Energy Star Label	
	Energy Source*	Standard Grid Electricty		Renewable Energy	
	Light Bulbs*	Incandescent/ Flourescent	CFL	LED	
	Light Switches	On/off switches	On/off switches w/ signs	Motion Activated	
	Hand Drying	Paper Towels	Hand Dryers	Air Blade Model	
			Total Energy Score		

		Indicators of Resource Consumption			
	Observations	(-1) High Consumption	(0) Minimal Impact	(+1) Sustainable	Score
Water	Irrigation Management	Automatic Sprinklers	Maintenance Plan	Low demand for water	
	Drinking Water	Water Bottles for Sale	Water Fountain	Bottle Refill Station	
	Toilets*	>3.5 gal. toilet	3.5-.1 gal toilet	Waterless toilet	
	Stormwater*		No Stormwater Management	Stormwater Management	
	Sinks	Traditional Faucets	Timer Faucets	Sensor Faucets	
			Total Water Score		

		Indicators of Resource Consumption			
	Observations	(-1) High Consumption	(0) Minimal Impact	(+1) Sustainable	Score
Waste	Concessions	Single Use Packaging	Recyclable Packaging	Reusable drink containers	
	Directions for Trash Disposal	No Directions Given	Ranger gave directions	Signage or clear directions	
	Trash	Trash cans only	Trash and recycling	Trash free park	
	Hand Drying	Paper Towels	Recycled paper towels	Hand Dryers	
	Education		No signs or info about waste	Signs or info about waste	
			Total Waste Score		

		Indicators of Resource Consumption			
	Observations	(-1) High Consumption	(0) Minimal Impact	(+1) Sustainable	Score
Visitor Transportation	Public Transportation	No Public Transportation	Accessible by bus	Accessible by Metro/Train	
	Bicycles	Bike Racks absent	Bike racks present, empty	Bike racks in use/Capital Bikeshare	
	Vehicles	< 50% of cars hybrid/electric	50-75% of cars hybrid/electric	>75% cars hybrid/electric	
	Vehicle Plug-In		No Station	Plug-In Station	
			Total Transportation Score		

If you found other areas of sustainability or impact, provide that information.

Observation	Score

Total Score	
Sustainability Rating	

Directions: Find the total score for all of the sustainability areas and then an overall total. Use the scale below to assign a Sustainability Rating.

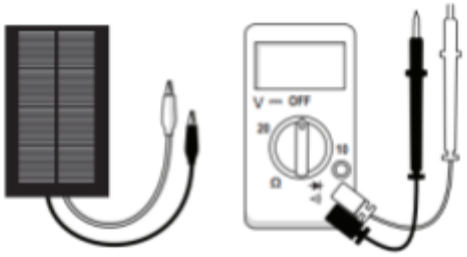
Heavy Impact	Average Impact			Minimal Impact			Mildly Sustainable			Highly Sustainable
≤ -10	-8	-6	-4	-2	0	2	4	6	8	≥ 10

Solar Scavenger Hunt

Your group will use the solar scavenger hunt to find an ideal place for solar energy harvesting.

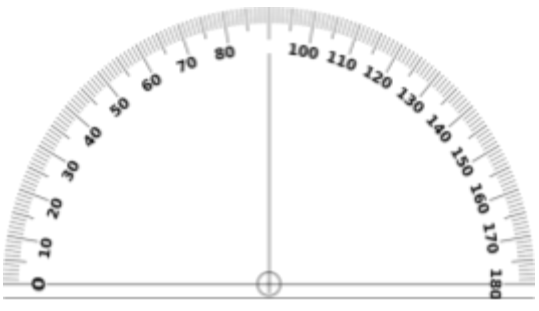
1. Assign roles for each group member. Roles include:
    a. Holding the solar panel
    b. Holding the multimeter
    c. Recording on the scavenger hunt data sheet
    d. Holding the protractor and measuring the angle of the panel
2. Set up the multimeter using the following steps:
    a. Place the black (negative) wire sleeve into the hole marked COM
    b. Place the red (positive) wire sleeve into the hole marked VΩMA
    c. Connect the red probe to the red alligator clip on the solar panel
    d. Connect the black probe to the black alligator clip on the solar panel
    e. Turn the dial till it is pointed at 20 V ⎓ on the section in the top left corner
3. Find a spot that is a good representation of the overall location
4. Use the following instructions to determine the amount of solar energy reaching the panel
    a. Place the solar panel on the ground so that it is at a 0° angle as measured on the protractor. Leave the panel on the ground for 15 seconds and watch the multimeter for the highest amount.
        i. Record the highest amount achieved as stated on the multimeter
    b. Raise one end of the panel towards the sun until it is at a 45° angle as measured on the protractor. Hold the panel for 15 seconds and watch the multimeter for the highest amount.
        i. Record the highest amount achieved as stated on the multimeter
    c. *Optional:* Watch the multimeter, then raise and lower one end of the panel towards the sun until the highest amount is shown on the multimeter. Observe and record which angle provided the most energy. Hold the solar panel at this angle for 15 seconds.
        i. Record the highest amount of energy as stated on the multimeter
        ii. Record the optimal angle
5. Repeat steps 3 & 4 to determine the best location

Clean up: Place panel back into its protective sleeve. Wrap wires and secure with rubber band. Place the panel, protractor, multimeter and wires in the box.



Solar Panel

Multimeter



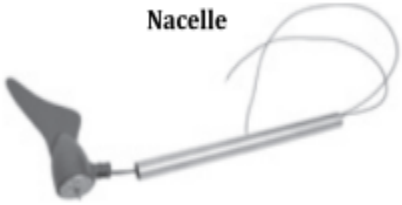
Protractor

Wind Energy Engineering

For this activity, you will become a wind turbine engineer. Many considerations go into designing these renewable energy structures. To maximize the efficiency of these renewable energy structures, a turbine may vary in the number of blades, pitch (angle) of each blade, shape of the blade, and blade material.

1. Set up your wind turbine:
    a. Uncoil the wires of your nacelle (plastic covered housing with the generating components) and push the wires down the aluminum tower.
    b. Push the wires through the wooden base.
    c. Slide the tower through the wooden base.
    d. Connect one end of the red alligator clips to the frayed red wire.
    e. Connect one end of the black alligator clips to the frayed black wire.
2. As a group, choose the blades you would like to attach to the hub. The blades should all be the same material (balsa or chipboard) and shape (squared or rounded).
3. Unscrew hub by twisting the wingnut in a counterclockwise direction and insert blades into the appropriate holes. *You will likely need more than one person to complete these steps. Measure the angle of each blade using the following steps:
    a. Place the yellow protractor so that the notch is around the dowel of the blade and the protractor extends over the wingnut of the hub.
    b. Turn the blade until it lines up to the angle you would like to use.
    c. Repeat the steps above for each blade, making sure that all blades are turned at the same angle.
    d. Tighten the hub by twisting the wingnut in a clockwise direction.
4. Record the number of blades, blade material (balsa or chipboard), shape of blades (squared or rounded), and angle of your blades on your data sheet.
5. Prepare the multimeter using the following steps:
    a. Plug the black wire sleeve into the hole marked COM.
    b. Plug the red wire sleeve into the hole marked VΩMA.
    c. Connect the red probe to the remaining red alligator clip and black probe to the remaining black alligator clip.
    d. Turn the dial until it is pointed at 20 on the V ⎓ section in the top left corner.
6. Push hub gently onto nacelle.
7. Using a ruler, set the turbine one foot away from the fan. Turn the fan to the highest setting. Leave the fan on for fifteen seconds. *If your blades do not begin to turn immediately, give a gentle push on the blades.*
8. The multimeter will display the amount of energy generated in Volts. Watch the multimeter and record the highest voltage reached on your data sheet.
9. Disassemble your hub and change <u>one variable</u> (# of blades, material, shape, or angle) to try and generate more energy.
10. Repeat procedure for a total of 4 trials

Nacelle



Nacelle with aluminum tower

Nacelle with wires through tower and base

Finished turbine

Blade

Multimeter with wire set-up

Protractor

Wind Energy Engineering

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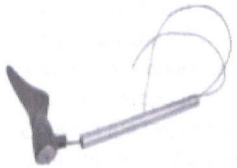
Nacelle

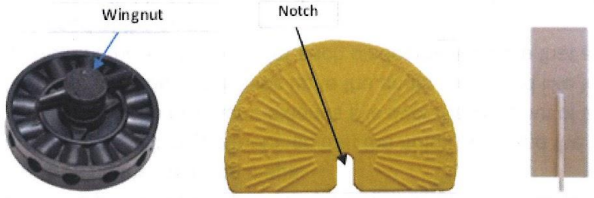


Nacelle with aluminum tower

Nacelle with wires through tower and base

Finished turbine

2. As a group, choose what the blades you would like to attach to the hub. The blades should all be the same material (balsa or chipboard) and shape (squared or rounded).



3. Unscrew hub by twisting the wingnut in a counter-clockwise direction and insert blades into the appropriate holes. *You will likely need more than one person to complete these steps. Measure the angle of each blade using the following steps:
   a. Place the yellow protractor so that the notch is around the dowel of the blade and the protractor extends it is over the wing nut of the hub.
   b. Turn the blade until it lines up to the angle you would like to use.
   c. Repeat the steps above for each blade, making sure that all blades are turned at the same angle.
   d. Tighten the hub by twisting the wingnut in a clockwise direction.
4. Record the number of blades, blade material (balsam or chipboard), shape of blades (squared or rounded), and angle of your blades on your data sheet.
5. Prepare the multimeter using the following steps:
   a. Plug the black wire sleeve into the hole marked COM.
   b. Plug the red wire sleeve into the hole marked VΩMA.
   c. Connect the red probe to the remaining red alligator clip and black probe to the remaining black alligator clip.
   d. Turn the dial until it is pointed at 20 on the V ⎓ section in the top left corner.
6. Push hub gently onto nacelle.
7. Using the a ruler, set the turbine one foot away from the fan. Turn the fan to the highest setting. Leave the fan on for fifteen seconds. *If your blades do not begin to turn immediately, give a gentle push on the blades.*
8. The multimeter will display the amount of energy generated in Volts. Watch the multimeter for approximately 15 seconds and record the highest amount voltage reached on your data sheet.
9. Disassemble your hub and change <u>one variable</u> (# of blades, material, shape, or angle) to try and generate more energy.
10. Repeat procedure for a total of 4 trials.

Multimeter with wire set-up

Clean up: Disconnect all alligator clips. Wrap wires and secure with rubber band. Place the tower base in box first. Place the nacelle, all wires, hub, blades, multimeter, and protractor back in the box.

Letter Reflection Model

Dear Park Ranger of X Park,

Our class from X school visited your park on X date to do the Bridging the Watershed sustainability module. We enjoyed learning about the sustainable efforts that the park is doing in the following categories: energy used, and the way it was generated, water consumption, waste, and transportation. We scored the park on all of these categories and came up with an overall class score of X. After doing more research as a class we would like to make the following recommendations to your park to help with its sustainable efforts.

- A
- B
- C

Thank you for allowing our class to come out to the park and learn about its sustainable efforts.

Sincerely,

X class

School Sustainability Report Card Focus Area Worksheets

Focus Area Worksheet: Bathroom

In the bathroom, how do students dry their hands? (Waste 1)
(1) Air dryer
(0) Environmentally friendly paper products (100% post-consumer recycled content)
(-1) Paper towels

Are there any leaking water fountains or sinks? (Water 1)
(1) No
(-1) Yes

What kinds of sinks are available? (Water 2)
(1) Sensor or timed setting
(-1) Manual

Do the toilets have a dual flush option (a user pulls the handle up to flush liquid waste and pulls the handle down to flush solid waste)? (Water 3)
(1) Yes
(-1) No

What type of urinals are available? (Water 4)
(1) Waterless urinals
(-1) Flushing urinals

What type of light bulbs are used? (Energy 1)
(1) LED
(0) CFL
(-1) Incandescent or unknown

Does the bathroom have motion-sensor lights? (Energy 2)
(1) Yes
(-1) No

Does your school have any initiatives that encourage students/teachers to reduce water use (for example: rewards/incentives or signs reminding individuals to turn off faucets)? (Water 5)
(1) Yes
(-1) No

Focus Area Worksheet: Cafeteria

Count the number of appliances/electronics (for example: commercial oven, dishwasher, freezer, air conditioner, refrigerator, etc.). How many are Energy Star products? (Energy 3)
(1) 50% or more of the products carry the energy star label
(0) 25% - 50% of the products carry the energy star label
(-1) Less than 25% carry the energy star label

Where does produce served at lunch come from? (Transportation 1)
(1) School garden
(0) Locally grown (grown within 100 miles of school)
(-1) Not local/unknown

What does your school do with food waste? (Waste 2)
(1) Compost
(-1) Garbage

What are cafeteria cups/flatware/plates made of? (Waste 3)
(1) They are reusable items
(0) One time use items that are biodegradable
(-1) One time use items made of plastic or Styrofoam

What are cafeteria trays made of? (Waste 4)
(1) They are reusable items
(0) One time use items that are biodegradable
(-1) One time use items made of plastic or Styrofoam

Are recycling bins present? If yes, pre-sorted or single-stream recycling? (Waste 5)
(1) Yes, recycling is collected for three or more categories (paper, plastic, cans, etc.)
(0) Yes, for one or two categories only
(-1) No

Focus Area Worksheet: Classroom

Has your school developed programs or clubs addressing the issue of sustainability? (Energy 4)
(1) Yes
(-1) No

Where does your school get its energy? (Energy 5)
(1) Biofuel, solar, geothermal, hydropower, or wind
(-1) Coal, oil, or natural gas

Count the number of appliances/electronics (for example: computer, air conditioner, television, projector, etc.). How many are Energy Star products? (Energy 6)
(1) 50% or more of the products carry the energy star label
(0) 25% - 50% of the products carry the energy star label
(-1) Less than 25% carry the energy star label

Does your school have any initiatives that encourage students/teachers to reduce energy (for example: rewards/incentives or signs reminding individuals to turn off lights and appliances)? (Energy 7)
(1) Yes
(-1) No

What type of office paper is used at your school? (Waste 6)
(1) At a minimum, 30% recycled content paper
(-1) Standard office paper or unknown

Does your school turn off heating/air conditioning when not in use (at night/weekends)? (Energy 8)
(1) Yes
(-1) No

What type of light bulbs are used? (Energy 9)
(1) LED
(0) CFL
(-1) Incandescent or unknown

Does your school have a high reflectance roof or green roof (use satellite imagery to determine)? (Energy 10)
(1) Yes
(-1) No or unknown

How are school/classroom newsletters, announcements, field trip information, meeting information, etc. disseminated to parents? (Waste 7)
(1) Mostly e-mail/website
(0) Some electronic, some paper
(-1) Printed paper

Is a recycling bin present? If yes, pre-sorted or single-stream recycling? (Waste 8)
(1) Yes, for three or more categories (paper, plastic, cans, etc.)
(0) Yes, for one or two categories only
(-1) No

Focus Area Worksheet: Schoolyard/Parking Lot

How many people are employed at your school (teachers, cafeteria staff, administrators, etc.)? Count the number of vehicles in the parking lot. (Transportation 2)
(1) There are 50% fewer cars in the parking lot than employees
(0) There are 25% fewer cars in the parking lot than employees
(-1) There is about one car per employee

Is there a vehicle charging station on site? (Transportation 3)
(1) Yes
(-1) No

Does your school have bike racks? Are they used? (Transportation 4)
(1) There are bike racks and they are 50% - 100% full of bikes
(0) There are bike racks and they are 0% - 50% full of bikes
(-1) There are no bike racks

Are there any rewards or incentives for teachers/students who walk to school, carpool, bicycle, or use public transportation? (Transportation 5)
(1) Yes
(-1) No

Does your school have a no-idle policy for school buses? (Transportation 6)
(1) Yes, and there are signs for reminding drivers
(0) Yes, but there are no signs for reminding drivers
(-1) No

How much of the landscaped school area includes rain gardens, pollinator gardens, or water-efficient native plants? (Water 6)
(1) More than 50%
(0) 25% - 50%
(-1) Less than 25%

Where does landscaping water come from? (Water 7)
(1) Rain barrel
(-1) Other

Deciduous trees block solar heat in the warmer months and cut air conditioning costs. Is shade from trees utilized to reduce solar heat gain? (Energy 11)
(1) Yes, trees have been planted in strategic locations around the building (shade majority of windows and part of the building's roof) or they shade pavement in parking lots
(0) Trees have been planted but they are not planted in strategic locations
(-1) No, there are very few trees present

How much of the landscaped school grounds area is turf? (Water 8)
(1) Less than 25%
(0) 25% - 50%
(-1) More than 50%

Score Sheet on Following Page

Score Page

Energy Score

1	2	3	4	5	6	7	8	9	10	11	Energy Total ____

Transportation Score

1	2	3	4	5	6	Trans Total ____

Water Score

1	2	3	4	5	6	7	8	Water Total ____

Waste Score

1	2	3	4	5	6	7	8	Waste Total ____

Energy + Transportation + Water + Waste = Total Score				
Energy _____	Transportation _____	Water _____	Waste _____	Total _____

Heavy Impact	Average Impact	Minimal Impact	Mildly Sustainable	Highly Sustainable
-17 +	-16 -6	-5 0 5	6 16	17+