2018
EDITION

Experience Energy

Grades 3-8

CLIMATE
GENERATION

Dear Educator

As an organization focused primarily on addressing climate change through education, Climate Generation believes that change happens at the local level and action begins with education. Our focus is to increase the connections educators and students make in their everyday life and motivate them to positively reduce the impact that climate change is having on our environment and economy.

Energy education is an important component of comprehensive climate change education and essential to achieving climate literacy. We need to become energy literate, understanding the connection between our energy use and consumption, the resulting impact on our climate, and energy solutions that mitigate its impact.

As an educator, you play a very important role not only in how and what learning opportunities you provide to your students, but also the behavior you and your school model. In this curriculum, students learn the basics of energy, energy sources and ways we use energy; the connection between climate change and energy; the importance of energy efficiency and renewable energy as critical solutions; and, finally, use the concepts learned to design a low-carbon dream school. In the Appendix, we have included case studies of student energy action projects along with an action plan template with the hope that they provide some inspiration and ideas. Remember, you and your students are part of the solution!

By helping schools assess their energy footprint, they can save energy, save money, and model a sustainable, low-carbon school. From an energy efficiency standpoint, for instance, schools benefit in myriad ways by saving energy. Economist Amory Lovins points out that the U.S. could save up to 75% of the energy we use in ways that are cost-effective—with techniques that cost less than the electricity itself.

Below are some of the important benefits of addressing energy in your classroom and school:

- Reduces energy waste: nearly 1/3 of energy consumed in schools is not used efficiently.
- Saves money: annual energy costs can reach up to $250 per student and energy is a major source of avoidable spending.
- Changes behavior: instilling wise energy habits and appropriate conservation behavior in students creates lifelong conservationists and teaches them to care about their actions.
- Improves the learning environment: there is a positive correlation between the physical conditions of the learning environment and student performance. Many energy efficient practices help create better lighting, temperature control, acoustics and air quality.
- Develops 21st century skills: these lessons provide students and educators with the opportunity to extend, explore, explain and evaluate. Energy is connected to their lives through real investigations and the development of authentic questions; and students are asked to apply what they learn in new situations.

Thank you for your commitment to educating your students about the critical issue of climate change and energy and engaging them in solutions, at home and in school!

The Climate Generation Education Team

Acknowledgments

June 2018

Major funding for this project was provided by

Center for Energy and Environment

with additional support from

IBERDROLA RENEWABLES

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Graphics provided by CEE's Minnesota Energy Challenge.
Other decals used with permission of CEE.

Graphic design and printing by Smart Set, smartset.com

Revised June, 2018

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About Climate Generation

Climate Generation

Climate Generation is a nationally connected and trusted nonprofit dedicated to climate literacy, climate change education, youth leadership and citizen engagement for innovative climate change solutions.

Climate Generation has a unique story that stems from our founder, Will Steger, a recognized authority on the Polar Regions and an eyewitness to the effects of climate change. Will has spent more than 50 years traveling through the Polar Regions, advocating for the Earth's preservation and advising on permanent solutions to climate change. His compelling eyewitness account of the consequences of a warming world in the Arctic and Antarctic has engaged thousands of people in the issue and solutions. It is Will's historical achievements as an explorer, educator and advocate that has shaped the core programming of Climate Generation. Climate Generation was established in 2006 with the mission of educating and empowering people to engage in solutions to climate change.

We recognize educators are critical messengers of climate and energy literacy, and schools and nonformal learning centers provide powerful examples of sustainability in communities. We also recognize that youth will inherit the unparalleled impacts of climate change and are among our most powerful advocates. With these factors guiding our approach, Climate Generation is having a tangible impact through climate literacy, youth leadership, and citizen engagement on climate change solutions.

Education Program History and Mission

When Climate Generation was founded in 2006 the education program was centered on adventure learning and expeditions by raising awareness of climate change in the Polar Regions. Although the education program has evolved, we still stay committed to the idea of eyewitness accounts and the metaphor of the expedition.

To reflect the evolution of our education program, and to stay current with the field of climate change education, our strategic goal was revised in 2011:

> *"to support educators, students and the public with science-based interdisciplinary educational resources on climate change, its implications and solutions to achieve climate literacy."*

We accomplish this through curriculum development, professional development, online resources and education partnerships.

Curricula Resources

Climate Generation offers a suite of Grades 3-12 curriculum resources. Aligned with national and Minnesota state standards, the Next Generation Science Standards (July 2014) and the climate and energy literacy principles, the curricula has been reviewed by scientists, professional educators, and organizations. All lessons have online connections in the form of videos, articles and other content and can be downloaded for free from http://climategen.org/curricula-resources/

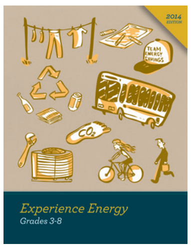
Our Changing Climate for Grades 3-6
These five lesson plans are interdisciplinary in nature, standards-based, help students master the requisite background information on global climate change processes, and teach how to communicate about the issue using communication strategies.

Our Changing Climate for Grades 6-12
These six interdisciplinary lesson plans help students master the requisite background information on global climate change processes, the importance of the Arctic to global climate, the potential effects of climate change in the Arctic, and to consider what could/should be done in response.

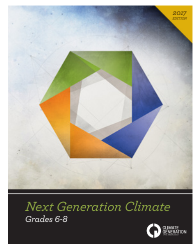
About Climate Generation

Minnesota's Changing Climate for Grades 3-8, 9-12
This set of lesson plans explores Minnesota's unique biomes and what a changing climate will mean for the state. It is considered a model for place-based climate change education.

Citizen Climate for Grades 9-12
Citizen Climate is for high school students and focuses on global climate solutions. It emphasizes civic engagement and helps teachers and students understand the critical and complex climate solutions being discussed on the national and international stage.



Experience Energy for Grades 3-8
These lessons introduce students to energy basics, emphasizes the connection between our energy use and consumption, the resulting impact on our climate, and energy solutions that mitigate its impact.



Next Generation Climate for Grades 6-8
This six-lesson, interdisciplinary, middle school climate change curriculum helps students investigate the cause of the global temperature change, research the major repercussions of climate change, and find out how they can monitor and minimize those repercussions. Next Generation Climate allows students to dive deep into data and practice the skills of argumentation and engineering design.

Online Curriculum

Arctic Community
This curriculum features the Arctic community as seen by animals, native peoples, explorers and scientists; all with diverse perspectives and ways of knowing, and all contributing to knowledge and action to slow climate change. The focus is on solutions and positive messages of hope and action.

Minnesota's Changing Climate
This online classroom was developed in conjunction with the Minnesota's Changing Climate lessons. Through the classroom students have the opportunity to learn about Minnesota's unique biomes and the impacts of climate change.

Professional Development Opportunities

Summer Institute for Climate Change and Energy Education
Climate Generation has provided professional development to teachers for six years through annual Summer Institutes. The institutes provide teachers with tools to communicate climate change in the classroom. Past keynote speakers have included Bill McKibben, Dr. James Hansen, Andrew Revkin, Dr. Genie Scott and Dr. Naomi Oreskes.

Webinar Series
Climate Generation offers frequent climate and energy literacy webinars featuring climate change and energy experts and education resources. Webinars are archived and can be accessed via the website.

Custom Workshops
The Climate Generation staff would love to work with your school, nature center, district or other educational setting to design a workshop focused on a variety of topics related to climate change and energy.

Online Resources

Climate Lessons Blog for Educators
Climate Generation maintains a blog dedicated to providing tools and references for educators and communicators of climate change.

Video Gallery
Climate Generation's video gallery contains 100's of videos featuring past expedition footage in polar regions, as well as presentations by leading climate scientists and other climate educators.

Energy Literacy

Essential Principles and Fundamental Concepts for Energy Education

The Energy Literacy Principles were developed as a culmination of a series of public listending sessions. Thousands of experts contributed to the dialogue about what an energy literate person should know and understand. According to the energy literacy document from the US Department of Energy, “Energy literacy is an understanding of the nature and role of energy in the universe and in our lives. Energy literacy is also the ability to apply this understanding to answer questions and solve problems.”

An energy-literate person:
-can trace energy flows and think in terms of energy systems
-knows how much energy he or she uses, for what, and where the energy comes from
-can assess the credibility of information about energy
-can communicate about energy and energy use in meaninful ways
-is able to make informed energy and energy use decisions based on an understanding of impacts and consequences
-continues to learn about energy through his or her life
(Energy Literacy, US Department of Energy, 2012)

Essential Principle/Fundamental Concept						
Physical Science	Lesson					
1. Energy is a physical quantity that follows precise natural laws.	*1*	*2*	*3*	*4*	*5*	*6*
1.1 Energy is a quantity that is transferred from system to system. Energy is the ability of a system to do work. A system has done work if it has exerted a force on another system over some distance. When this happens energy is transferred from one system to another. At least some of the energy is also transformed from one type into another during this process. One can keep track of how much energy transfers into or out of a system.	x	x				
1.2 The energy of a system or object that results in its temperature is called thermal energy. When there is a net transfer of energy from one system to another, due to a difference in temperature, we call the energy transferred heat. Heat transfer happens in three ways: convection, conduction and radiation. Like all energy transfer, heat transfer involves forces exerted over a distance at some level as systems interact.						
1.3 Energy is neither created nor destroyed. The change in the total amount of energy in a system is always equal to the difference between the amount of energy transferred in and the amount transferred out. The total amount of energy in the universe is finite and constant.	x					
1.4 Energy available to do useful work decreases as it is transferred from system to system. During all transfers of energy between two systems, some energy is lost to the surroundings. In a practical sense, this lost energy has been “used up,” even though it is still around somewhere. A more efficient system will lose less energy, up to a theoretical limit.						
1.5 Energy comes in different forms and can be divided into categories. Forms of energy include light energy, elastic energy, chemical energy and more. There are two categories that all energy falls into, kinetic and potential. *Kinetic* describes types of energy associated with motion, and the word *potential* describes energy possessed by an object or system due to its position relative to another object or system and forces between the two. Some forms of energy are part kinetic and part potential energy.	x					
1.6 Chemical and nuclear reactions involve transfer and transformation of energy. The energy associated with nuclear reactions is much larger than that associated with chemical reactions for a given amount of mass. Nuclear reactions take place at the centers of stars, in nuclear bombs and in both fission- and fusion-based nuclear reactors. Chemical reactions are pervasive in living and nonliving Earth systems.						

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1.7 Many different units are used to quantify energy. As with other physical quantities, many different units are associated with energy. For example, joules, calories, ergs, kilowatt-hours and BTUs are all units of energy. Given a quantity of energy in one set of units, one can always convert it to another (e.g., 1 calorie = 4.186 joules).						
1.8 Power is a measure of energy transfer rate. It is useful to talk about the rate at which energy is transferred from one system to another (energy per time). This rate is called power. One joule of energy transferred in one second is called a watt (I.e., 1 joule/second = 1 watt).			x			
Earth Science	Lesson					
2. Physical processes on Earth are the result of energy flow through the Earth system.	*1*	*2*	*3*	*4*	*5*	*6*
2.1 Earth is constantly changing as energy flows through the system. Geologic, fossil and ice records provide evidence of significant changes throughout Earth's history. These changes are always associated with changes in the flow of energy through the Earth system. Both living and nonliving processes have contributed to this change.						
2.2 Sunlight, gravitational potential, decay of radioactive isotopes, and rotation of the Earth are the major sources of energy driving physical processes on Earth. Sunlight is a source external to Earth while radioactive isotopes and gravitational potential, with the exception of tidal energy, are internal. Radioactive isotopes and gravity work together to produce geothermal energy beneath Earth's surface. Earth's rotation influences global flow of air and water.	x					
2.3 Earth's weather and climate is mostly driven by energy from the Sun. For example, unequal warming of Earth's surface and atmosphere by the Sun drives convection within the atmosphere, producing winds, and influencing ocean currents.						
2.4 Water plays a major role in the storage and transfer of energy in the Earth system. This is due to water's prevalence, high heat capacity, and the fact that phase changes of water occur regularly on Earth. The sun provides the energy that drives the water cycle on Earth.						
2.5 Movement of matter between reservoirs is driven by Earth's internal and external sources of energy. These movements are often accompanied by a change in the physical and chemical properties of the matter. Carbon, for example, occurs in carbonate rocks such as limestone, in the atmosphere as carbon dioxide gas, in water as dissolved carbon dioxide, and in all organisms as complex molecules that control the chemistry of life. Energy drives the flow of carbon between these different reservoirs.						
2.6 Greenhouse gases affect energy flow through the Earth system. Greenhouse gases in the atmosphere, such as carbon dioxide and water vapor, are transparent to much of the incoming sunlight but not to the infrared light from the warmed surface of Earth. These gases play a major role in determining average global surface temperatures. When Earth emits the same amount of energy as it absorbs, its average temperature remains stable.		x				
2.7 The effects of changes in Earth's energy system are often not immediately apparent. Responses to changes in Earth's energy system, input versus output, are often only noticeable over the course of months, years or even decades.						

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Life Science *3. Biological processes depend on energy flow through the Earth system.*	Lesson *1*	*2*	*3*	*4*	*5*	*6*
3.1 The Sun is the major source of energy for organisms and the ecosystems of which they are a part. Producers such as plants, algae and cyanobacteria use the energy from sunlight to make organic matter from carbon dioxide and water. This establishes the beginning of energy flow through almost all food webs.	x					
3.2 Food is a biofuel used by organisms to acquire energy for internal living processes. Food is composed of molecules that serve as fuel and building material for all organisms as energy stored in the molecules is released and used. The breakdown of food molecules enables cells to store energy in new molecules that are used to carry out the many functions of the cell and thus the organism.	x					
3.3 Energy available to do useful work decreases as it is transferred from organism to organism. The chemical elements that make up the molecules of living things are passed through food chains and are combined and recombined in different ways. At each level in a food chain, some energy is stored in newly made chemical structures, but most is dissipated into the environment. Continual input of energy, mostly from sunlight, keeps the process going.						
3.4 Energy flows through food webs in one direction, from producers to consumers and decomposers. An organism that eats lower on a food chain is more energy efficient than one eating higher on a food chain. Eating producers is the lowest, and thus most energy efficient, level at which an animal can eat.						
3.5 Ecosystems are affected by changes in the availability of energy and matter. The amount and kind of energy and matter available constrains the distribution and abundance of organisms in an ecosystem and the ability of the ecosystem to recycle materials.						
3.6 Humans are part of Earth's ecosystems and influence energy flow through these systems. Humans are modifying the energy balance of Earth's ecosystems at an increasing rate. The changes happen, for example, as a result of changes in agricultural and food processing technology, consumer habits, and human population size.						
Engineering, Technology & Practice *4. Various sources of energy can be used to power human activities, and often this energy must be transferred from source to destination.*	Lesson *1*	*2*	*3*	*4*	*5*	*6*
4.1 Humans transfer and transform energy from the environment into forms useful for human endeavors. The primary sources of energy in the environment include fuels like coal, oil, natural gas, uranium and biomass. All primary source fuels except biomass are nonrenewable. Primary sources also include renewable sources such as sunlight, wind, moving water, and geothermal energy.	x	x		x	x	x
4.2 Human use of energy is subject to limits and constraints. Industry, transportation, urban development, agriculture, and most other human activities are closely tied to the amount and kind of energy available. The availability of energy resources is constrained by the distribution of natural resources, availability of affordable technologies and socio-economic policies and status.				x	x	x

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4.3 Fossil and bio fuels are organic matter that contain energy captured from sunlight. The energy in fossil fuels such as oil, natural gas and coal comes from energy that producers such as plants, algae and cyanobacteria captured from sunlight long ago. The energy in biofuels such as food, wood, and ethanol comes from energy that producers captured from sunlight very recently. Energy stored in these fuels is released during chemical reactions, such as combustion and respiration, which also release carbon dioxide into the atmosphere.	x	x				
4.4 Humans transport energy from place to place. Fuels are often not used at their source but are transported, sometimes over long distances. Fuels are transported primarily by pipelines, trucks, ships, and trains. Electrical energy can be generated from a variety of energy resources and can be transformed into almost any other form of energy. Electric circuits are used to distribute energy to distant locations. Electricity is not a primary source of energy, but an energy carrier.		x				
4.5 Humans generate electricity in multiple ways. When a magnet moves or magnetic field changes relative to a coil of wire, electrons are induced to flow in the wire. Most human generation of electricity happens in this way. Electrons can also be induced to flow through direct interaction with light particles; this is the basis upon which a solar cell operates. Other means of generating electricity include electrochemical, piezoelectric and thermoelectric.		x		x	x	x
4.6 Humans intentionally store energy for later use in a number of different ways. Examples include batteries, water reservoirs, compressed air, hydrogen and thermal storage. Storage of energy involves many technological, environmental and social challenges.	x					
4.7 Different sources of energy and the different ways energy can be transformed, transported and stored each have different benefits and drawbacks. A given energy system, from source to sink, will have an inherent level of energy efficiency, monetary cost and environmental risk. Each system will also have national security, access and equity implications.		x			x	x
Social Science - Decisions				*Lesson*		
5. Energy decisions are influenced by economic, political, environmental and social factors.	*1*	*2*	*3*	*4*	*5*	*6*
5.1 Decisions concerning the use of energy resources are made at many levels. Humans make individual, community, national and international energy decisions. Each of these levels of decision making have some common and some unique aspects. Decisions made beyond the individual level often involve a formally established process of decision making.						

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5.2 Energy infrastructure has inertia. The decisions that governments, corporations, and individuals made in the past have created today's energy infrastructure. The large amount of money, time, and technology invested in these systems make changing the infrastructure difficult, but not impossible. The decisions of one generation both provide and limit the range of possibilities open to future generations.		x				
5.3 Energy decisions can be made using a systems-based approach. As individuals and societies make energy decisions, they can consider the costs and benefits of each decision. Some costs and benefits are more obvious than others. Identifying all costs and benefits requires a careful and informed systems-based approach to decision making.		x		x	x	x
5.4 Energy decisions are influenced by economic factors. Monetary costs of energy affect energy decision making at all levels. Energy exhibits characteristics of both a commodity and a differentiable product. Energy costs are often subject to market fluctuations, and energy choices made by individuals and societies affect these fluctuations. Cost differences also arise as a result of differences in energy source and as a result of tax-based incentives and rebates.		x	x			
5.5 Energy decisions are influenced by political factors. Political factors play a role in energy decision making at all levels. These factors include, but are not limited to, governmental structure and power balances, actions taken by politicians, and partisan-based or self-serving actions taken by individuals and groups.						
5.6 Energy decisions are influenced by environmental factors. Environmental costs of energy decisions affect energy decision making at all levels. All energy decisions have environmental consequences. These consequences can be positive or negative.		x		x		
5.7 Energy decisions are influenced by social factors. Questions of ethics, morality and social norms affect energy decision making at all levels. Social factors often involve economic, political and environmental factors.				x		
Social Science - Behavior			*Lesson*			
6. The amount of energy used by human society depends on many factors.	1	2	3	4	5	6
6.1 Conservation of energy has two very different meanings. There is the physical law of conservation of energy. This law says that the total amount of energy in the universe is constant. Conserving energy is also commonly used to mean the decreased use of societal energy resources. When speaking of people conserving energy this second meaning is always intended.				x		
6.2 One way to manage energy resources is through conservation. Conservation includes reducing wasteful energy use, using energy for a given purpose more efficiently, making strategic choices as to sources of energy, and reducing energy use altogether.				x	x	x
6.3 Human demand for energy is increasing. Population growth, industrialization and socio-economic development result in increased demand for energy. Societies have choices with regard to how they respond to this increase. Each of these choices has consequences.						
6.4 Earth has limited energy resources. Increasing human energy consumption places stress on the natural processes that renew some energy resources and it depletes those that cannot be renewed.		x			x	

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6.5 Social and technological innovation affects the amount of energy used by human society. The amount of energy society uses per capita or in total can be decreased. Decreases can happen as a result of technological and social innovation and change. Decreased use of energy does not necessarily equate to decreased quality of life. In many cases it will be associated with increased quality of life in the form of increased economic and national security, reduced environmental risks and monetary savings.				x		
6.6 Behavior and design affect the amount of energy used by human society. There are actions individuals and society can take to conserve energy. These actions might come in the form of changes in behavior or in changes to the design of technology and infrastructure. Some of these actions have more impact than others.				x		x
6.7 Products and services carry with them embedded energy. The energy needed for the entire life cycle of a product or service is called the "embedded" or "embodied" energy. An accounting of the embedded energy in a product or service along with knowledge of the source(s) of the energy is essential when calculating the amount of energy used and in assessing impacts and consequences.						
6.8 Amount of energy used can be calculated and monitored. An individual, organization or government can monitor, measure and control energy use in many ways. Understanding utility costs, knowing where consumer goods and food come from, and understanding energy efficiency as it relates to home, work and transportation are essential to this process.			x	x		
Social Science - Quality of Life				*Lesson*		
7. The quality of life of individuals and societies is affected by energy choices.	*1*	*2*	*3*	*4*	*5*	*6*
7.1 Economic security is influenced by energy choices. Individuals and society continually make energy choices that have economic consequences. These consequences come in the form of monetary cost in general and in the form of price fluctuation and instability specifically.						
7.2 National security is influenced by energy choices. The security of a nation is dependent, in part, on the sources of that nation's energy supplies. For example, a nation that has diverse sources of energy that come mostly from within its borders is more secure than a nation largely dependent on foreign energy supplies.						
7.3 Environmental quality is influenced by energy choices. Energy choices made by humans have environmental consequences. The quality of life of humans and other organisms on Earth can be significantly affected by these consequences.		x				
7.4 Increasing demand for and limited supplies of fossil fuels affects quality of life. Fossil fuels provide the vast majority of the world's energy. Fossil fuel supplies are limited. If society has not transitioned to sources of energy that are renewable before depleting Earth's fossil fuel supplies, it will find itself in a situation where energy demand far exceeds energy supply. This will have many social and economic consequences.		x			x	
7.5 Access to energy resources affects quality of life. Access to energy resources, or lack thereof, affects human health, access to education, socio-economic status, gender equality, global partnerships and the environment.						
7.6 Some populations are more vulnerable to impacts of energy choices than others. Energy decisions have economic, social and environmental consequences. Poor, marginalized or underdeveloped populations can most benefit from positive consequences and are the most susceptible to negative consequences.						

Next Generation Science Standards (NGSS)

In 2013, the NGSS were released as the most current, research- based way of educating students in STEM and preparing them for STEM careers. The NGSS establishes high standards for delivering effective STEM education. They challenge us to provide the instructional support in our curriculum resources and to make NGSS accessible to educators in the classroom. Hands on learning, effective communication, making connections across all domains of science and other disciplines, an emphasis on including "all voices," and the importance of developing a learning progression are not only integral to the NGSS, but have always guided Climate Generation's development of educational resources.

NGSS performance expectations represent the final assessment of learning and therefore cannot fully develop a student's full mastery. Additionally, true NGSS instruction and learning is three dimensional- including not only core ideas (CI), but cross cutting concepts (CCC) and scientific and engineering practices (SEP) as well. Lesson plans that best support NGSS performance expectations, CI, CC and SEP are listed below.

Performance Expectations	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
Energy						
4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object.	•					
4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents	•	•			•	
4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.*					•	
4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.		•	•	•		
Engineering Design						
3-5-ETS1-1. Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.					•	•
3-5-ETS1-2. Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.					•	•
3-5-ETS1-3. Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved					•	•
Energy						
MS-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.					•	
MS-PS3-4. Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.			•	•	•	
MS-PS3-5. Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.	•					
Weather and Climate						
MS-ESS3-5. Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century		•				
Engineering Design						
MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.					•	•
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.					•	
MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.					•	

Next Generation Science Standards (NGSS) (cont.)

Physical Science Disciplinary Core Ideas						
PS3A - Definitions of Energy	•					
PS3B - Energy: Conservation & Transfer	•		•			
PS3C - Energy & Forces	•					
PS3D - Energy in Chemical Processes & Life	•					
Earth & Space Science Disciplinary Core Ideas						
ESS3C - Human Impacts on Earth Systems		•				
ESS3D - Global Climate Change		•				
Engineering, Technology & Applications of Science Disciplinary Core Ideas						
ETS1A - Defining & Delimiting an Engineering Problem					•	•
ETS1B - Developing Possible Solutions					•	
ETS1C - Optimizing the Design Solution					•	
ETS2A - Interdependence of Science, Engineering & Technology					•	
ETS2B - Influence of Science, Engineering & Technology on Society & the Natural World					•	
Cross Cutting Concepts						
1. Patterns. Observed patterns of forms and events guide organization and classification, and they prompt questions about relationships and the factors that influence them.	•	•			•	
2. Cause and effect: Mechanism and explanation. Events have causes, sometimes simple, sometimes multifaceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated. Such mechanisms can then be tested across given contexts and used to predict and explain events in new contexts.	•		•	•		
3. Scale, proportion, and quantity. In considering phenomena, it is critical to recognize what is relevant at different measures of size, time, and energy and to recognize how changes in scale, proportion, or quantity affect a system's structure or performance.	•	•	•			
4. Systems and system models. Defining the system under study—specifying its boundaries and making explicit a model of that system—provides tools for understanding and testing ideas that are applicable throughout science and engineering.	•					
5. Energy and matter: Flows, cycles, and conservation. Tracking fluxes of energy and matter into, out of, and within systems helps one understand the systems' possibilities and limitations.	•	•		•	•	•
6. Structure and function. The way in which an object or living thing is shaped and its substructure determine many of its properties and functions.					•	
7. Stability and change. For natural and built systems alike, conditions of stability and determinants of rates of change or evolution of a system are critical elements of study.		•	•	•	•	
Science and Engineering Practices						
1. Asking questions (for science) and defining problems (for engineering)		•	•	•	•	•
2. Developing and using models	•					•
3. Planning and carrying out investigations			•	•	•	
4. Analyzing and interpreting data		•		•		
5. Using mathematics and computational thinking				•		
6. Constructing explanations (for science) and designing solutions (for engineering)				•		
7. Engaging in argument from evidence				•		
8. Obtaining, evaluating, and communicating information	•	•	•	•	•	•

Minnesota Science Standards

Grade	Strand	Substrand	Standard "Understand that ...	Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
3	1. The Nature of Science and Engineering	1. The Practice of Science	1. Scientists work as individuals and in groups; emphasizing evidence, open communication and skepticism.	3.1.1.1.1	Provide evidence to support claims, other than saying "Everyone knows that," or "I just know," and question such reasons when given by others.		x	x	x	x	x
3	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes incorporating multiple approaches that are used to pose questions about the natural world and investigate phenomena.	3.1.1.2.3	Maintain a record of observations, procedures and explanations, being careful to distinguish between actual observations and ideas about what was observed. For example: Make a chart comparing observations about the structures of plants and animals.		x	x			
3	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes incorporating multiple approaches that are used to pose questions about the natural world and investigate phenomena.	3.1.1.2.4	Construct reasonable explanations based on evidence collected from observations or experiments.			x	x		
3	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	4. Tools and mathematics help scientists and engineers see more, measure more accurately, and do things that they could not otherwise accomplish.	3.1.3.4.1	Use tools, including rulers, thermometers, magnifiers and simple balance, to improve observations and keep a record of the observations made.			x			
4	1. The Nature of Science and Engineering	2. The Practice of Engineering	1. Engineers design, create, and develop structures, processes, and systems that are intended to improve society and may make humans more productive.	4.1.2.1.1	Describe the positive and negative impacts that the designed world has on the natural world as more and more engineered products and services are created and used.					x	x
4	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the process of identifying problems, developing multiple solutions, selecting the best possible solution, and building the product.	4.1.2.2.1	Identify and investigate a design solution and describe how it was used to solve an everyday problem. For example: Investigate different varieties of construction tools.					x	x

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4	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the process of identifying problems, developing multiple solutions, selecting the best possible solution, and building the product.	4.1.2.2.2	Generate ideas and possible constraints for solving a problem through engineering design. For example: Design and build an electromagnet to sort steel and aluminum materials for recycling.					x	x
4	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the process of identifying problems, developing multiple solutions, selecting the best possible solution, and building the product.	4.1.2.2.3	Test and evaluate solutions, considering advantages and disadvantages for the engineering solution, and communicate the results effectively.					x	x
4	2. Physical Science	3. Energy	2. Energy can be transformed within a system or transferred to other systems or the environment.	4.2.3.2.1	Identify several ways to generate heat energy. For example: Burning a substance, rubbing hands together, or electricity flowing through wires.	x	x			x	x
5	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a way of knowing about the natural world, is done by individuals and groups, and is characterized by empirical criteria, logical argument and skeptical review.	5.1.1.1.4	Understand that different models can be used to represent natural phenomena and these models have limitations about what they can explain. For example: Different kinds of maps of a region provide different information about the land surface.		x			x	
5	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations.	5.1.1.2.1	Generate a scientific question and plan an appropriate scientific investigation, such as systematic observations, field studies, open-ended exploration or controlled experiments to answer the question.			x		x	x
5	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations.	5.1.1.2.2	Identify and collect relevant evidence, make systematic observations and accurate measurements, and identify variables in a scientific investigation.		x	x			

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5	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations.	5.1.1.2.3	Conduct or critique an experiment, noting when the experiment might not be fair because some of the things that might change the outcome are not kept the same, or that the experiment isn't repeated enough times to provide valid results.			x	x	x	
5	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	4. Tools and mathematics help scientists and engineers see more, measure more accurately, and do things that they could not otherwise accomplish.	5.1.3.4.1	Use appropriate tools and techniques in gathering, analyzing and interpreting data. For example: Spring scale, metric measurements, tables, mean/median/range, spreadsheets, and appropriate graphs.			x	x		
5	1. The Nature of Science and Engineering	3. Interactions Among Science, Engineering, Technology and Society	4. Tools and mathematics help scientists and engineers see more, measure more accurately, and do things that they could not otherwise accomplish.	5.1.3.4.2	Create and analyze different kinds of maps of the student's community and of Minnesota. For example: weather maps, city maps, aerial photos, regional maps, or online map resources		x			x	
5	3. Earth Science	4. Human Interactions with Earth Systems	1. In order to maintain and improve their existence, humans interact with and influence Earth systems.	5.3.4.1.1	Identify renewable and nonrenewable energy and material resources that are found in Minnesota and describe how they are used. For example: Water, iron ore, granite, sand and gravel, wind, and forests.	x	x	x		x	x
6	1. The Nature of Science and Engineering	2. The Practice of Engineering	1. Engineers create, develop and manufacture machines, structures, processes and systems that impact society and may make humans more productive.	6.1.2.1.1	Identify a common engineered system and evaluate its impact on the daily life of humans. For example: refrigeration, cell phones, or automobiles				x	x	

Minnesota Science Standards

Grade	Strand	Substrand	Standard "Understand that ...	Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
6	1. The Nature of Science and Engineering	2. The Practice of Engineering	1. Engineers create, develop and manufacture machines, structures, processes and systems that impact society and may make humans more productive.	6.1.2.1.2	Recognize that there is no perfect design and that new technologies have consequences that may increase some risks and decrease others. For example: seat belts and airbags		x		x	x	x
6	1. The Nature of Science and Engineering	2. The Practice of Engineering	1. Engineers create, develop and manufacture machines, structures, processes and systems that impact society and may make humans more productive.	6.1.2.1.3	Describe the trade-offs in using manufactured products in terms of features, performance, durability and cost.		x			x	x
6	1. The Nature of Science and Engineering	2. The Practice of Engineering	1. Engineers create, develop and manufacture machines, structures, processes and systems that impact society and may make humans more productive.	6.1.2.1.4	Explain the importance of learning from past failures in order to inform future designs of similar products or systems. For example: space shuttle or bridge design		x		x	x	x
6	1. The Nature of Science and Engineering	2. The Practice of Engineering	2. Engineering design is the process of devising products, processes and systems that address a need, capitalize on an opportunity, or solve a specific problem.	6.1.2.2.1	Apply and document an engineering design process that includes identifying criteria and constraints, making representations, testing and evaluation, and refining the design as needed to construct a product or system to solve a problem. For example: Investigate how energy changes from one form to another by designing and constructing a simple roller coaster for a marble.					x	x
6	1. The Nature of Science and Engineering	3. Interactions Among Science, Technology, Engineering, Mathematics and Society	1. Designed and natural systems exist in the world. These systems consist of components that act within the system and interact with other systems.	6.1.3.1.1	Describe a system in terms of its subsystems and parts, as well as its inputs, processes and outputs.	x	x	x			

Minnesota Science Standards

Grade	Strand	Substrand	Standard "Understand that ...	Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
6	1. The Nature of Science and Engineering	3. Interactions Among Science, Technology, Engineering, Mathematics and Society	4. Current and emerging technologies have enabled humans to develop and use models to understand and communicate how natural and designed systems work and interact.	6.1.3.4.1	Determine and use appropriate safe procedures, tools, measurements, graphs, and mathematical analyses to describe and investigate natural and designed systems in a physical science context.			x	x		
6	2. Physical Science	3. Energy	2. Energy can be transformed within a system or transferred to other systems or the environment.	6.2.3.2.2	Trace the changes of energy forms, including thermal, electrical, chemical, mechanical or others as energy is used in devices. For example: A bicycle, light bulb or automobile.	x	x				
7	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry uses multiple interrelated processes to investigate questions and propose explanations about the natural world.	7.1.1.2.3	Generate a scientific conclusion from an investigation, clearly distinguishing between results (evidence) and conclusions (explanation).				x		
8	1. The Nature of Science and Engineering	1. The Practice of Science	1. Science is a way of knowing about the natural world and is characterized by empirical criteria, logical argument and skeptical review.	8.1.1.1.1	Evaluate the reasoning in arguments in which fact and opinion are intermingled or when conclusions do not follow logically from the evidence given. For example: Evaluate the use of pH in advertising products such as body care and gardening.		x		x		x
8	1. The Nature of Science and Engineering	1. The Practice of Science	2. Scientific inquiry is a set of interrelated processes incorporating multiple approaches that are used to pose questions about the natural and engineered world and investigate phenomena.	8.1.1.2.1	Use logical reasoning and imagination to develop descriptions, explanations, predictions and models based on evidence.					x	x
8	1. The Nature of Science and Engineering	3. Interactions Among Science, Technology, Engineering, Mathematics and Society	3. Science and engineering operate in the context of society and both influence and are influenced by this context.	8.1.3.3.1	Explain how scientific laws and engineering principles, as well as economic, political, social, and ethical expectations, must be taken into account in designing engineering solutions or conducting scientific investigations.		x		x		x

Minnesota Science Standards

Grade	Strand	Substrand	Standard "Understand that ...	Code	Benchmark	Lesson 1	Lesson 2	Lesson 3	Lesson 4	Lesson 5	Lesson 6
8	1. The Nature of Science and Engineering	3. Interactions Among Science, Technology, Engineering, Mathematics and Society	3. Science and engineering operate in the context of society and both influence and are influenced by this context.	8.1.3.3.3	Provide examples of how advances in technology have impacted how people live, work and interact.		x		x		
8	1. The Nature of Science and Engineering	3. Interactions Among Science, Technology, Engineering, Mathematics and Society	4. Current and emerging technologies have enabled humans to develop and use models to understand and communicate how natural and designed systems work and interact.	8.1.3.4.1	Use maps, satellite images and other data sets to describe patterns and make predictions about local and global systems in Earth science contexts. For example: Use data or satellite images to identify locations of earthquakes and volcanoes, ocean surface temperatures, or weather patterns.					x	
8	3. Earth Science	2. Interdependence Within the Earth system	2. Patterns of atmospheric movement influence global climate and local weather.	8.3.2.2.1	Describe how the composition and structure of the Earth's atmosphere affects energy absorption, climate, and the distribution of particulates and gases. For example: Certain gases contribute to the greenhouse effect.		x				
8	3. Earth Science	4. Human Interactions with Earth Systems	1. In order to maintain and improve their existence humans interact with and influence Earth systems.	8.3.4.1.1	Describe how mineral and fossil fuel resources have formed over millions of years, and explain why these resources are finite and non-renewable over human time frames.		x				
8	3. Earth Science	4. Human Interactions with Earth Systems	1. In order to maintain and improve their existence humans interact with and influence Earth systems.	8.3.4.1.2	Recognize that land and water use practices affect natural processes and that natural processes interfere and interact with human systems. For example: Levees change the natural flooding process of a river. Another example: Agricultural runoff influences natural systems far from the source.		x		x	x	x

Experience Energy 3-8 Lesson Organizer

Lesson Outcomes	Lesson Materials
Pre and Post Assessment	
Students will demonstrate their understanding of climate and energy concepts.	Pre and Post Assessment
Lesson 1: What is Energy?	
Students will be able to define energy transfer and fossil fuels. Students will be able to identify many different sources and carriers of energy and examples of energy in use. Students will be introduced to the kinetic and potential states of energy.	States of Energy Sorting Cards Energy Scavenger Hunt Worksheet
Lesson 2: What is the climate and energy connection?	
Students will be able to explain where their household and school energy comes from. Students will be able to define renewable, non-renewable energy and fossil fuels. Students will understand how Carbon Dioxide (CO_2) pollution from burning fossil fuels is changing the atmosphere and climate.	Minnesota Electricity Sources Cards Electricity Journey Cards Minnesota State Energy Map Minnesota Greenhouse Gas Emissions by Source Economics of Energy Energy Source Pros and Cons Worksheet
Lesson 3: How do we use energy in our classroom?	
Students will be able to explain where their household and school energy comes from. Students will be able to define renewable, non-renewable energy and fossil fuels. Students will understand how Carbon Dioxide (CO_2) pollution from burning fossil fuels is changing the atmosphere and climate.	School Energy Audit Worksheet What is the “cost” of energy use? Worksheet
Lesson 4: What are conservation and efficiency solutions?	
Students will be able to use and define the words conservation and efficiency as they relate to energy behaviors. Students will be able to create charts using data from the previous lesson and assess the results. Students will be able to prioritize efficiency and conservation decisions they can make in their own lives.	
Lesson 5: What are renewable energy solutions?	
Students will be able to use solar or wind energy to accomplish basic tasks of heating a food item and lifting pennies. Students will be able to define qualities of a well-engineered renewable energy project. Students will be able to explain which regions of Minnesota are best suited for certain renewable energy projects and why.	Minnesota Annual Average Wind Speed Photovoltaic Solar Resources of the United States Biomass Resources of the United States
Lesson 6: What would my dream green school look like?	
Students will apply knowledge gained from previous lessons to the design and creation of a model dream green school. Students will write position statements.	
Appendix- Case Studies and Action Plan Template	
Students will learn about energy action projects done by Minnesota students. Students will brainstorm energy action projects. Students will use a template to develop an energy action plan.	Action Plan Template

Energy Pre and Post Assessment

Assessment of student learning is divided into the following two parts:

Energy and Climate Pre/Post Test:	*Science Notebook:*
For those who want a summative assessment that clearly shows change in student understanding between the start and finish of this curriculum or a unit on energy and climate change. The Pre/Post test is intended to be both the first and last thing you do in this curriculum. The test is available for both grades 3-5 and 6-8 and is included in this section for easy printing and use.	For those seeking a more literacy-focused and formative assessment option to engage students in reflection and writing continuously throughout the lessons. The science notebook assignments will be included in each lesson as an activity and as an expected outcome.

Energy Pre and Post Assessment

Grades 3-5

Show us what you know! We want YOU to learn the most. This test helps us do that.

Your Name: ____________________ Class Period: ____________________

Are these statements True or False? (circle one answer)

1. Energy can only be used once before it is destroyed. **True** or **False**
2. Fossil Fuels are actually fossils. **True** or **False**
3. Most of Minnesota's electricity comes from burning coal. **True** or **False**

Multiple Choice (circle one answer)

1. ________ is the source of all motion, sound, heat and light.
   (a) Food (b) a Battery (c) Energy (d) Water

2. Which of the following is an example of Potential Energy:
   (a) The sun (b) a Barrel of oil (c) Wind (d) Fire

3. Which of the following is a source of Renewable Energy:
   (a) Gasoline (b) a Tree (c) a Computer (d) a Baseball

5. Carbon Dioxide (CO2) is a type of ________
   (a) Water (b) Soil (c) Fire (d) Greenhouse gas

Brainstorm (fill in the blanks with words or phrases)

(1) Energy comes from many sources. Name 4 energy sources in the following table:

(2) Energy is used in our homes and school in many ways. Name 4 energy uses in the following table:

Short Answer (use 1-3 complete sentences)

(1) Describe how burning fossil fuels for energy is changing the Earth's climate:

Energy Pre and Post Assessment
Grades 6-8

Show us what you know! We want YOU to learn the most. This test helps us do that.

Your Name: ____________________ Class Period: ____________________

Are these statements True or False? (circle one answer)

1. Energy can only be used once before it is destroyed. **True** or **False**
2. Humans are the source of all energy. **True** or **False**
3. Fossil Fuels are actually fossils. **True** or **False**
4. Electricity can be made by a wind turbine at night. **True** or **False**
5. Most of Minnesota's electricity comes from burning coal. **True** or **False**

Multiple Choice (circle one answer)

1. ________ is the source of all motion, sound, heat and light.
   (a) Electricity (b) a Battery (c) Energy (d) Water

2. Which of the following is an example of Potential Energy:
   (a) The sun (b) a Barrel of oil (c) Wind (d) Fire

3. Which of the following is a source of Renewable Energy:
   (a) Gasoline (b) a Tree (c) a Computer (d) a Baseball

4. Incandescent, fluorescent and LED are different types of ________
   (a) Lightbulbs (b) Chemicals (c) Air pollution (d) Windows

5. Carbon Dioxide (CO_2) is a type of ________
   (a) Water (b) Soil (c) Fire (d) Greenhouse gas

Brainstorm (fill in the blanks with words or phrases)

(1) Energy comes from many sources. Name 5 energy sources in the following table:

(2) Energy is used in our homes and school in many ways. Name 5 energy uses in the following table:

Short Answer (use 2-4 complete sentences)

(1) Describe how burning fossil fuels is changing the Earth's climate:

ANSWER KEY

Energy & Climate Pre/Post Test, Grades 3-5

Are these statements True or False? (circle one answer)

1. Energy can only be used once before it is destroyed. True or **False**
2. Fossil Fuels are actually fossils. **True** or False
3. Most of Minnesota's electricity comes from burning coal. **True** or False

Multiple Choice (circle one answer)

1. ________ is the source of all motion, sound, heat and light.
   (a) Food (b) a Battery **(c) Energy** (d) Water

2. Which of the following is an example of Potential Energy:
   (a) A flowing river **(b) a Barrel of oil** (c) Wind (d) Fire

3. Which of the following is a source of Renewable Energy:
   (a) Gasoline **(b) a Tree** (c) a Computer (d) a Baseball

4. Carbon Dioxide (CO_2) is a type of ________
   (a) Water (b) Soil (c) Fire **(d) Greenhouse gas**

Brainstorm (fill in the blanks with words or phrases)

(1) Energy comes from many sources. Name 4 energy sources in the following table:

Acceptable answers include:

Sun	Food	Wind
Natural gas	Nuclear	Oil
Gasoline	Water (hydroelectric)	Coal
		Wood (biomass)

(2) Energy is used in our homes and school in many ways. Name 4 energy uses in the following table:

Acceptable answers include (but not limited to):

Television	Washing machine	Projector
Toaster	Hot tub	Alarm clock
Stereo system	Video game systems	Shower (hot water)
Computer	Blender	Lights
Hair dryer	Clothes dryer	Phone

Short Answer (use 1-3 complete sentences)

(1) Describe how burning fossil fuels for energy is changing the Earth's climate:

Acceptable answers include the following details:

Burning fossil fuels (like coal or oil) releases greenhouse gases

Greenhouse gases trap heat in the atmosphere, changing the weather and/or climate

ANSWER KEY

Energy & Climate Pre/Post Test, Grades 6-8

Are these statements True or False? (circle one answer)

1. Energy can only be used once before it is destroyed. True or **False**
2. Humans are the source of all energy. True or **False**
3. Fossil Fuels are actually fossils. **True** or False
4. Electricity can be made by a wind turbine at night. **True** or False
5. Most of Minnesota's electricity comes from burning coal. **True** or False

Multiple Choice (circle one answer)

1. ________ is the source of all motion, sound, heat and light.
   (a) Food (b) a Battery **(c) Energy** (d) Water

2. Which of the following is an example of Potential Energy:
   (a) A flowing river **(b) a Barrel of oil** (c) Wind (d) Fire

3. Which of the following is a source of Renewable Energy:
   (a) Gasoline **(b) a Tree** (c) a Computer (d) a Baseball

4. Incandescent, fluorescent and LED are different types of ________
   (a) Lightbulbs (b) Chemicals (c) Air pollution (d) Windows

5. Carbon Dioxide (CO_2) is a type of ________
   (a) Water (b) Soil (c) Fire **(d) Greenhouse gas**

Brainstorm (fill in the blanks with words or phrases)

(1) Energy comes from many sources. Name 5 energy sources in the following table:

Sun	Food	Wind
Natural gas	Nuclear	Oil
Gasoline	Water (hydroelectric)	Coal
		Wood (biomass)

(2) Energy is used in our homes and school in many ways. Name 5 energy uses in the following table:
Acceptable answers include (but are not limited to):

Television	Washing machine	Projector
Toaster	Hot tub	Alarm clock
Stereo system	Video game systems	Shower (hot water)
Computer	Blender	Lights
Hair dryer	Clothes dryer	Phone

Short Answer (use 2-4 complete sentences)

(1) Describe how burning fossil fuels is changing the Earth's climate:
Acceptable answers include the following details:
Burning fossil fuels (like coal or oil) releases Carbon Dioxide, a greenhouse gas
Greenhouse gases trap heat in the atmosphere from the sun
The extra heat in the atmosphere changes the climate

Lesson 1: Introduction to Energy

"Energy is everywhere and makes everything happen"

Age Level:	Grades 3-8
Time Needed:	60-90 minutes, could be broken up into 45 minute segments
Materials:	Energy Scavenger Hunt worksheets Classroom board or large sheet of paper Writing utensils Clip boards (optional) States of Energy Sorting Cards Science notebooks
Student Learning Outcomes:	Students will be able to define energy transfer and fossil fuels. Students will be able to identify many different sources and carriers of energy and examples of energy in use. Students will be introduced to the kinetic and potential states of energy.

Background

Energy is defined as: "a quantity that is transferred from system to system" (US Department of Energy). It is the ability to create sound, motion, heat or light. Energy is never created or destroyed. It is not a tangible thing; you cannot hold it in your hand or fill a jar with pure energy, yet it is essential to all life and all activity in the known universe.

Lesson 1 begins to raise student awareness of common energy sources and uses. This lesson is the foundation for this curriculum as it aims to inspire more questions than it answers.

The States of Energy

Energy is described as having two distinct states: **potential energy** is when it is stored and waiting to be used and **kinetic energy** is energy in use. Energy changes between these two states over and over again indefinitely—we call each change a **transfer of energy**. Energy is neither created nor destroyed. All matter contains at least some potential energy. For energy to transfer throughout the earth's systems and our lives, it often must become kinetic (US Department of Energy).

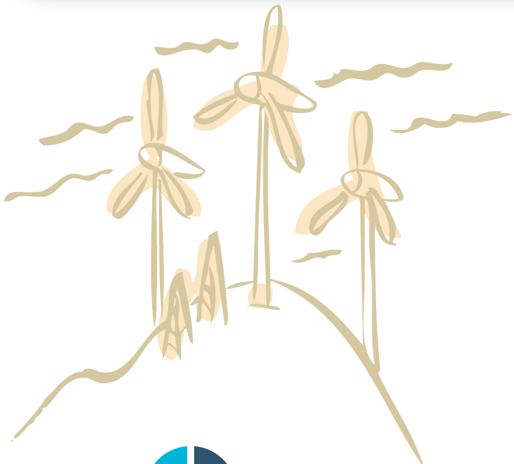
Food chains and food webs make for great examples of this phenomenon. For instance: a plant grows in a garden due to kinetic energy from sunlight. Some of this energy is stored in the plant as potential energy, causing it to grow in size. When the plant dies, this same energy becomes kinetic again and is transferred into the soil as nutrients which feed bacteria, insects and fungi. The circle of life is really "the circle of energy."

Common Sources of Energy

"Oil, coal, biomass (wood and plant material), natural gas, solar, wind and nuclear are some of the most-used **energy sources** in the United States today. We call them *sources* in everyday conversation, and in this curriculum, but really they are **energy carriers** because they do just that: carry energy for a period of time. Because energy passes from system to system, we can't really say that any of those systems are the "source."

Energy makes change; it does things for us. It moves cars along the road and boats over the water. It bakes a cake in the oven and keeps ice frozen in the freezer. It plays our favorite songs on the radio and lights our homes. Energy makes our bodies grow and allows our minds to think. Scientists define energy as the ability to do work.

- The NEED Project "Power to the Plug"



Oil, coal, and natural gas are called **fossil fuels** because they are actually fossilized matter from once-living organisms. Plant and marine life from over hundreds of thousands of years ago became trapped beneath the Earth and, by heat and pressure, were transformed into oil, coal, and natural gas (US Department of Energy).

The ultimate source of most energy on earth is the sun. Fossil fuels and wind energy are all the result of the sun's energy acted out upon plants and animals (for fossil fuels) and the earth's land, sea and atmosphere (for wind). The plants that became fossil fuels needed the sunlight and warmth to grow, wind results from heating and cooling of the earth, and solar power transforms the sun's rays into electricity. It's the sun's energy, transferring and taking on different forms (US Department of Energy).

Educators please note that your students may have the misconception that energy is a substance that can be found. Fuels can be found; the stored energy in the fuel can be transformed into other forms. The fuel or food is not the source of the energy.

Notebook Assignment

At the end of this lesson student notebooks should include definitions of the following:

- Energy (from: Notebook Activity)
- Energy Transfer (from: Energy Defined in a Day)
- Kinetic Energy (from: Energy Defined in a Day)
- Potential Energy (from: Energy Defined in a Day)

Activity Description

Opening Activity: Energy Defined in a Day (20 min.), Grades 3-5 & 6-8

Raise awareness of energy used each day and create a visual, working definition of energy.

Materials:

Notebook paper
Writing utensil
Interactive whiteboard or large piece of paper (for mind map)

Instructions

1. Ask students to make a list of everything that they have done today beginning with when they woke up (take 5 minutes or so). Encourage them to be specific and to include as many steps as possible.
2. When finished, ask them to "circle everything on the list that used energy". (Some will likely ask, "doesn't all of this use energy?" Reply only with the original request, to "circle everything on the list that used energy to complete.")
3. Next, have students share their lists with one another and then share a few with the large group:
   What is something they circled?
   In what ways does this activity use energy?
   Does everything use energy? What's something you did today that didn't use energy?
   Ask the class "what is energy?"
4. Together—on your interactive whiteboard or a large piece of paper—make a mind map (See Figure 1 & 2) that defines energy in their own words. Use words, colors and images. This mind map will be referenced again and it is most useful if it can be stored on paper or digitally on an interactive whiteboard. If students run out of ideas, you can ask:
   "How can we tell if something is using energy?"
   "What sources of energy can you think of?"

5. Prompt students to ponder one of the fundamental laws of energy:
   Say, and add to the board, **"Energy is never created or destroyed."**
   Ask the students to agree or disagree with this statement and state their case. (Note: energy is just a quantity that passes from system to system. When we think it is "gone" or when, for example our gas tank is empty, it's not because that energy has completely disappeared. Rather, it transferred into heat and motion to move your vehicle. The energy still exists: it has just transferred to a different system.)

In the absence of a working definition, you can share this definition, from the National Energy Education Development Project (NEED): "Energy produces light ... heat ... motion ... sound ... growth and powers technology."

6. Note: Now would be a fine time to introduce the vocabulary words: *kinetic energy* and *potential energy* by having students add examples of each of these two energy states to the mind map. This would be especially timely if students are talking about themselves as "carriers of energy" (potential) and "users of energy" (kinetic). We will cover those concepts in greater detail in the next activity.

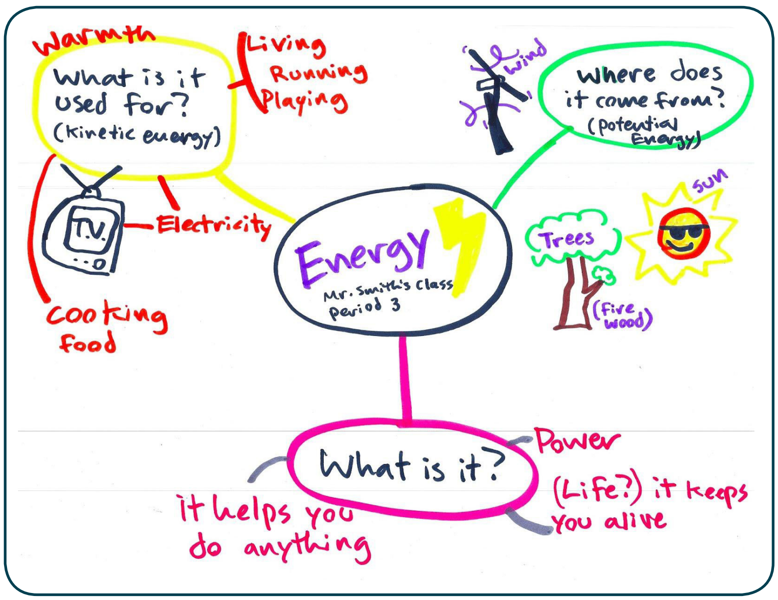


Figure 1: Example of a simple mind map with energy at the center.

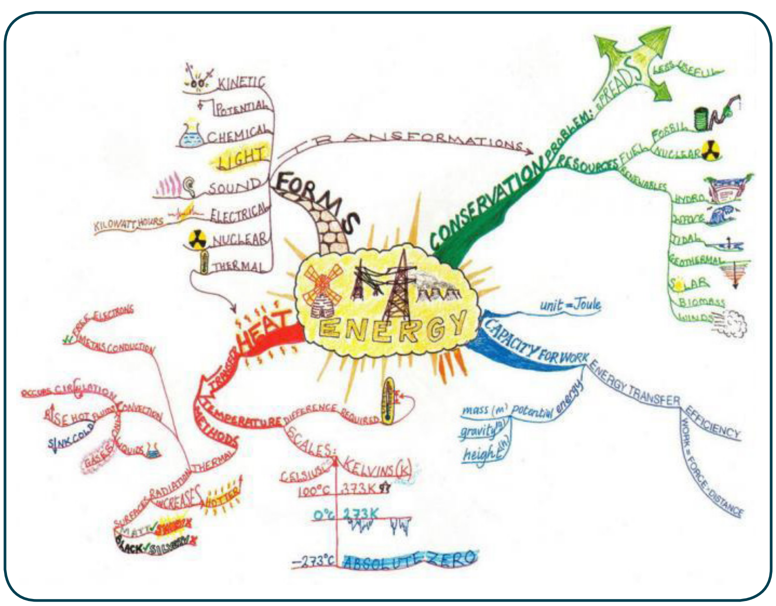


Figure 2: Example of a more complex mind map with higher-level vocabulary words related to energy, many of which we will not get into even in later lessons. (Source: www.mindwerx.com, Creative Commons license)

Take it Outside

Activity: Where Can Energy Be Found? (25 min.), Grades 3-5 & 6-8

Inquire into the presence of energy outdoors, build sensory awareness of biomass, wind, solar and other local energy sources and carriers.

Materials:

Clip board (optional)
Writing utensils
Energy Scavenger Hunt sheet (1 sheet for every 2-3 students)

Instructions:

1. Take students outside to an open area and ask them to create a safe space around themselves by spreading their arms outward. Ask students to use as much energy as they can—or to make as much of their energy "kinetic" as possible—for the next 30 seconds.
   a. NOTE: Of course this activity should be done without students hurting themselves or each other and while remaining within appropriate area boundaries. You may suggest that they spread out first and choose to run in place, do "jumping jacks", talk, sing, even yell.
2. When 30 seconds have passed, ask them to STOP using any energy for the next 15 seconds. Ask them:
   a. "Did you do it? Can you stop using energy? Why or why not?" (answer: the human body continues to use energy even when we stand still. No, we never stop using energy until we die.)
   b. "Where do we get our energy?" (answer: we get it from food)
   c. "Where is that energy stored—after we eat—as potential energy?" (answer: fat and muscle mainly comprise our bodily potential energy).
   d. "So, does that make us an example of potential energy, kinetic energy or both?" (answer: both, as we have potential energy stored at all times and are using energy at all times, until we die). Make sure the students understand that potential energy is "carried" and kinetic energy is "used."
3. To prepare for the scavenger hunt, hike around the school or to your outdoor classroom to note any local energy sources - trees/timber, plants, animals (which we use for energy in the source of food), the sun, wind, even the moon (the moon controls high and low tide and capturing tidal energy is being explored in some coastal regions). Ask students to explain:
   a. "If this is an energy source, then what is its purpose?"
   b. "Who does it give energy to? Where does it get its energy from?"
   c. Promote having students give their evidence and reasoning for their answers (claims) and encourage discussion and challenges. Avoid a definitive 'right or wrong' classification and explain that "we will likely change our answers as we learn more about energy."
4. Have students form groups of 2-3 for the Energy Scavenger Hunt. This is a fairly straightforward scavenger hunt. The groups will go out looking for the items, find the items and return as fast as they can. This scavenger hunt is made to work for many school yards but can freely be customized to fit your unique situation. Most of the items to be hunted for do not need to be picked-up or otherwise collected, students simply need to record what they find by writing it on the Scavenger Hunt Worksheet.
5. As they return, reflect on what everyone found:
   a. What did they notice?
   b. What was easiest to find?
   c. What was hardest to find?

6. Back in the classroom, record your outdoor energy observations on the board, and in their notebooks. You might choose to add what they found to the mind map you started earlier.
7. Ask students to reflect on:
    a. How would we use these types of energy?
    b. How do other living things use them?
    c. How do we capture the energy inside of these things we observed?

Concluding Activity: Kinetic vs. Potential Energy (15 min.), Grades 3-5

Sort the States of Energy Sorting Cards into either kinetic energy, potential or both.

Materials:

States of Energy Sorting Cards

Instructions:

1. With students gathered in a large group, hold up one energy sorting card – perhaps something straightforward like the "matchstick" card – and read the description on the card. When finished, ask the group is this an object that is carrying energy, using energy, neither, or both? Once again, avoid a definitive 'right or wrong' classification and explain that "we will likely change our answers as we learn more about energy."
2. Bridge the use of energy carrier and user to the definitions of potential and kinetic energy. From now on ask the question, "does it have potential or kinetic energy, neither or both?" Go through two or three example cards together and have the class decide whether the image is an example of potential energy, kinetic energy, neither, or both, each time.
3. Next, in small groups, have students sort all of the cards into three categories: Does the card show (1) kinetic energy, (2) potential energy or (3) both?
4. Debrief the activity by having students justify their answers to one another or to you. Ask:
    a. Which of the examples show a transfer of energy—where energy moves from one form to another?
    b. What advice would you give someone who was trying to understand potential and kinetic energy? What about energy transfer?
5. Conclude the activity with students writing definitions of *kinetic*, *potential* and *transfer of energy*, including examples, in their notebooks.

Final Notebook Reflection

Write a definition of energy in your science notebooks and see who can make the shortest, true definition. Note, a few examples of acceptable short definitions include: "energy allows everything to happen", "verbs use energy" or "energy fuels life". Draw a picture that shows energy transfer and give an example.

VOCABULARY

Energy: The ability to create sound, motion, heat or light.

Energy sources (a.k.a. Energy carriers): The vehicles of energy.
Examples include: electricity, coal, as well as any food source.

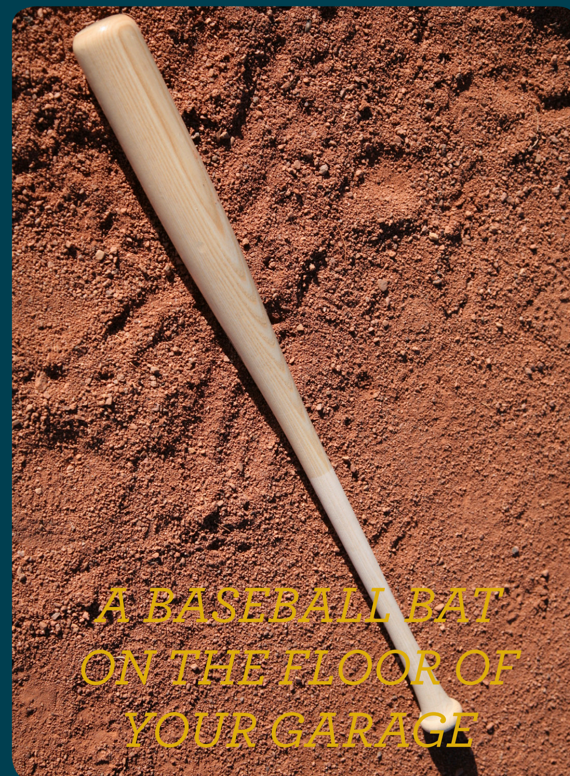
Energy Transfer: When energy changes forms and/or becomes used by a different system (e.g., burning coal to boil water transfers energy from the coal to the water)

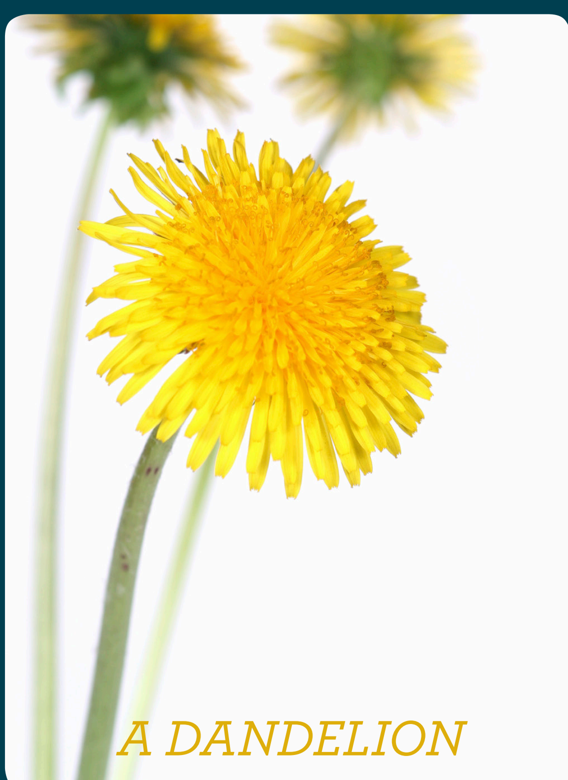
Fossil Fuels: Sources of energy made from ancient plant and marine life that formed over hundreds of thousands of years of heat and pressure.

Kinetic Energy: Energy in use.
Example: a fire burning or wind blowing.

Potential Energy: Energy stored or waiting to be used.
Example: a ball at the top of a hill or a full tank of gas.


A SPOTTED DOG RUNNING


A BASEBALL BAT ON THE FLOOR OF YOUR GARAGE


A DANDELION

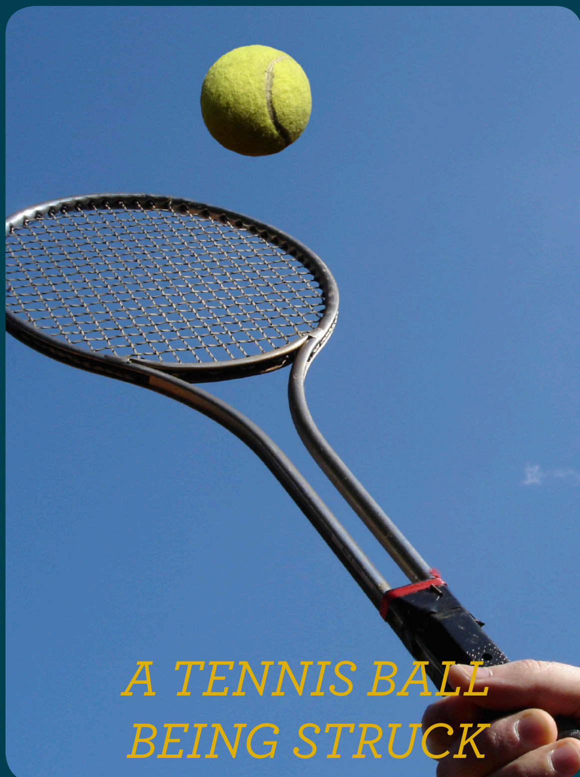

A SKIER AT THE TOP OF THE HILL

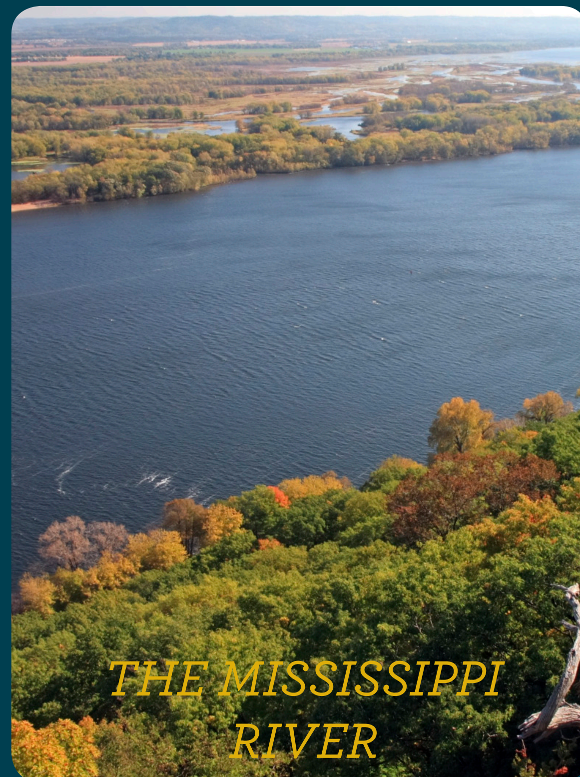
A MATCHSTICK

A MATCHSTICK ON FIRE

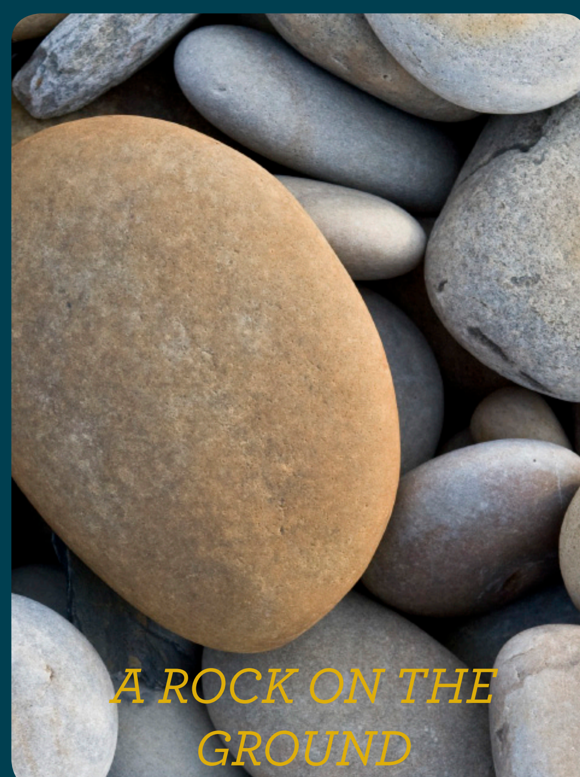
A DECK OF PLAYING CARDS

A SLICE OF PIZZA


A TENNIS BALL
BEING STRUCK


THE MISSISSIPPI
RIVER


AN OIL TANK
TRUCK


A ROCK ON THE
GROUND

Energy Scavenger Hunt Worksheet

Instructor note: Assign clear physical boundaries and behavior expectations. Be sure to clearly explain that all students must return to you when you give a signal that the activity is finished (a whistle, a yell, a howl, whatever). Some of the scavenger hunt items may not apply to your location - you may add or subtract items from the list at your discretion.

Also note: "collecting" these items may not be possible. We recommend that students only "see" or "experience" the item hunted in order for it to count as "collected."

Find the following things and hurry back as quick as you can!

1. Something that is producing light. What is it?

2. A living animal and determine what food source it gets its energy from.

3. Three things with potential energy or "energy sources." What are they?

4. Something that uses the wind's energy. What is it?

5. Three things showing kinetic energy or an "energy transfer." What are they?

BONUS: Someone or something using energy in-efficiently. (more on this in lesson 4)

ANSWER KEY

States of Energy Sorting Cards

Note: These cards are intentionally made to look simple, but many are more nuanced and complicated, as reflected by the explanations in the answers below.

Baseball bat on the floor of your garage: Only potential energy

A dandelion: Both kinetic and potential energy (because it is growing and using energy as well as storing it, even though it is growing very slowly)

A deck of cards: Only potential energy

A matchstick: Only potential energy

A matchstick on fire: Both kinetic and potential energy

The Mississippi River: Only kinetic energy

An oil tank truck: Only potential energy

A piece of pizza: Only potential energy

A rock on the ground: Only potential energy

A skier at the top of a hill: Both kinetic and potential energy (because the skier is living, they are using energy and have stored energy in fat and muscle. The hill is significant as well: it gives added potential energy to the skier)

Spotted dog running: Both kinetic and potential energy (because it is both using energy to run and contains more stored energy in its fat and muscle)

A tennis ball being struck: Only kinetic energy

ANSWER KEY
Energy Scavenger Hunt

Instructor note: Many of the items on this list are to be interpreted by you and your students. It's our belief that this will employ higher-level reasoning on their behalf. It may require you to make judgment calls. For this reason, we encourage making this only a "friendly competition" – a clear winner may not exist!

Find the following things and hurry back as quick as you can!

1. Something that is producing light. What is it?

   Acceptable answers include, but are not limited to: The sun, streetlamps, car headlights, a cell phone, a flashlight, an "Exit" sign, etc.

2. A living animal and determine what food source it gets its energy from.

   Acceptable answers include, but are not limited to: A squirrel (energy from food/nuts), birds (energy from food/insects/seeds), humans (energy from food), etc.

3. Three things with potential energy, or "energy carriers". What are they?

   Acceptable answers include, but are not limited to: A tree, grass, classmates/people (we carry energy in our bodies), animals, etc.

4. Something that uses the wind's energy. What is it?

   Acceptable answers include, but are not limited to: a bird, a tree or flower (many of which use the wind to spread seeds), a leaf, a flag, etc.

5. Three things showing kinetic energy , or an "energy transfer". What are they?

   Acceptable answers include, but are not limited to: other students, a leaf falling, a plane flying, a car in motion, the wind, any animal noise or motion, etc.

BONUS: Someone or something using energy in-efficiently. (more on this in lesson 4)

Acceptable answers include, but are not limited to: Someone not wearing a jacket in cold weather is using extra energy to keep themselves warm, a car driving fast in a residential neighborhood, a school with the windows covered on a sunny, cold day (preventing infrared heat from warming the room), etc.

Age Level:	Grades 3-8
Time Needed:	90 minutes or 2, 45 minute periods
Materials:	Writing utensils Electricity Journey Cards Minnesota Electricity Source Cards Minnesota State Energy Map Science notebooks Copies of Pros and Cons Worksheet
Student Learning Outcomes:	Students will be able to explain where their household and school energy comes from Students will be able to define renewable, non-renewable energy and fossil fuels Students will understand how Carbon Dioxide (CO_2) pollution from burning fossil fuels is changing the atmosphere and climate

Background

Building on lesson 1, this lesson will deepen one's understanding of energy sources and their impacts, especially greenhouse gas pollution and climate change.

Lesson 2 explores the link between energy sources used in Minnesota and pros and cons. For example, Minnesota's burning coal and natural gas is releasing greenhouse gases that cause climate change.

Coal is Minnesota's main source of electricity, oil fuels our transportation, and our main source of heat is natural gas (US Energy Information Administration "MN State Energy Profile"). When we burn these fossil fuels, we release carbon dioxide (or CO_2) into the atmosphere, a known greenhouse gas.

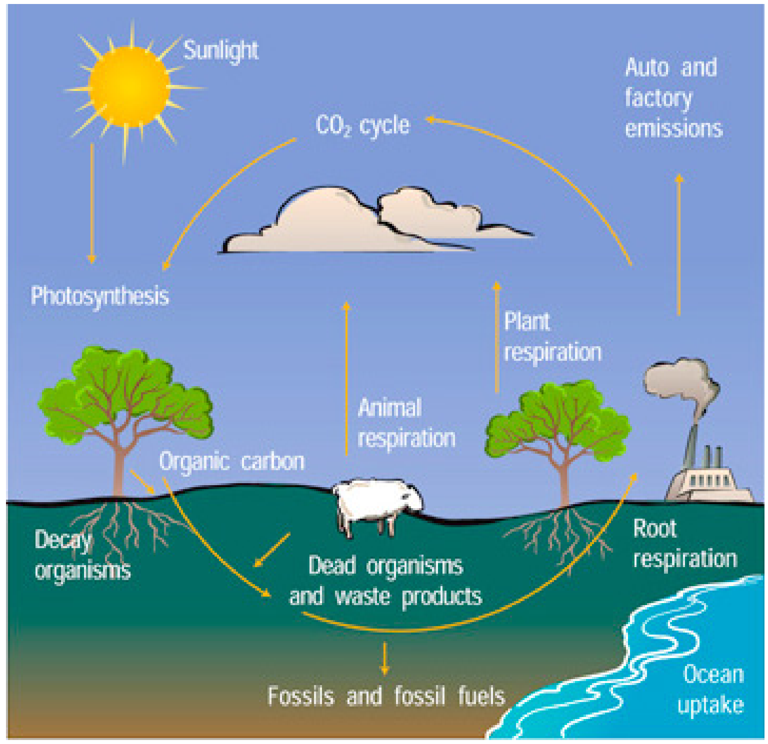
CO_2 in the Earth's atmosphere has well-understood properties including absorbing infrared heat as it enters and escapes the planet. This heat warms the Earth's surface and makes the planet an inhabitable place for life as we know it. This process is called the greenhouse effect. CO_2 is a naturally-occurring gas in the atmosphere. However, as we add large amounts of greenhouse gases to the atmosphere, it leads to major changes in the climate globally and locally. (US Energy Information Administration "What are greenhouse gases and how much are emitted by the United States?").

CO_2 levels in the atmosphere are kept in balance due mainly to plants and the ocean which capture CO_2 out of the air. This is part of the carbon cycle. The carbon cycle refers to the fact that the element carbon naturally passes from system to system – like energy. For example, carbon gets added to the atmosphere through the burning of fossil fuels (i.e. emissions) and gets absorbed out of the atmosphere through plant photosynthesis.

Burning fossil fuels for energy has put more CO_2 into the atmosphere since the industrial revolution than the carbon cycle is able keep up with. This means we are increasing CO_2 concentrations in the atmosphere and the impacts on climate are

> *Energy is at the heart of the global warming challenge. It is humanity's production and use of energy that is the primary cause of global warming, and in turn, climate change will eventually affect our production and use of energy.*
>
> - US Global Change Research Program

measurable here and abroad*. In Minnesota we are seeing these changes in many ways including in the form of shorter and warmer winters, the earlier arrival of some spring migrations and warmer summer evenings.



(Source: National Center for Atmospheric Research)

The CO2 emissions we produce in Minnesota alone add to this issue. For example, in 2011, Minnesota burned 17,846,000 tons of coal. That coal provided for 53% of the state's electricity usage. It weighed the same as 600,000 snow plow trucks in weight, which, if driven bumper to bumper, would stretch from southern Minnesota to Guatemala in Central America. (North Dakota Department of Transportation). Most of it was brought in by rail car 400 miles from Wyoming and Montana (Xcel Energy).

Also in 2011, Minnesota used 420,000+ million cubic feet of natural gas. That's equivalent to the volume of 65,750,000 classrooms. That's enough for every K-12 student in Minnesota to have 70 natural gas-filled classrooms (assuming that the average classroom is 20'X40'8' in dimensions).

Combined, these two energy sources contributed 159,820,000 classrooms full of CO2 to the atmosphere in 2011; or 170 classrooms of CO2 per Minnesota student (US Energy Information Administration, Education Minnesota).

*Note: for more on climate change, its evidence, impacts, and the greenhouse effect, check out Climate Generation's *Next Generation Climate* and other content available to download at www.climategen.org/curricula-resources

Notebook Assignment

At the end of this lesson student notebooks should include one pro and one con for each energy source and definitions of the following:
Fossil fuels (from: Introduction to the "Cost" of Energy)
Non-renewable energy (from: Energy Pros and Cons)
Renewable energy (from: Energy Pros and Cons)

Activity Description

Introduction Activity

1. Ask students to reflect on what happens when you plug something into the wall. Electricity flows into whatever we just plugged in, but where does that electricity come from? Can we know the source of our electricity?
2. In their notebooks students should draw how they think this process occurs.
3. Explain that today we will begin answering this question and discuss the pros and cons of various energy sources we use.

Take it Outside

Activity: Electricity Journey, Grades 3-8
Take a walking tour of the pathway electricity takes to get to your school

Materials:
Electricity Journey Cards
Minnesota Electricity Sources Cards

Instructions:
Teacher Prep: Photocopy and possibly laminate source cards.

1. Prepare your students to go outside and split them into small groups. Walk outside to the nearest power line and explain: "This is a power line, and it's near the end of the journey that energy takes to get to our school and homes. We're going to look back to the source and follow it all the way here."
2. In their small groups ask them to take turns reading their first Electricity Journey card to their small group. Each card contains a question prompt or two for the group to consider and discuss. Ask small groups to share out their answers to the larger group.
3. Also on each card is a distance that the group will travel along beneath the power line, following it to the school. At each stop, continue to have the students work in their small groups, sharing answers and clarifying with the larger group. Allow each group to take a turn walking the distance to the next stop in the journey.

Note: the distances on the back of each card are arbitrary and do not represent real information about any energy system. However, coal and oil are not mined in Minnesota and therefore the longest distance traveled in the coal or oil energy journey is that of delivering the extracted material to our state. Therefore, we have started with longer distances and the other distances are shorter and varied to represent the other distances traveled generally.

4. At each stop, be sure to encourage students to ask questions, listen actively and gather close enough to hear the speaker.
5. At the final stop, collect all the cards and ask some review questions.
    a. Who can describe for me the process by which energy gets to our school?
    b. Who can name all the steps in the journey of electricity? Are there any steps that you think we might have missed?

Activity: Introduction to the "Cost" of Energy, Grades 3-8

Materials:
Electricity Source cards (enough sets for each small group)
Minnesota Greenhouse Gas Emissions by Source Figure
Comparing the Cost of Energy Figure
CO2 cards with rankings

1. We briefly discussed the various places we get energy in Minnesota in the last activity. In this activity we will begin to compare sources and how we might measure their "cost." Begin with a discussion about how we measure the value of something. For example if we are going to buy a new bike, how do we

decide which one to buy? How much money it costs comes into play, but are there other things they might consider too? What about color? If it is used or new? If it is made out good material? Have they ever considered if it is made out of materials that are recycled?

2. Hand out the set of 8 energy source cards to small groups photo side up. Ask the students not to turn them over to read the information yet. As a class look at them and review each source of energy. Which ones are fossil fuels? If you were going to label the other sources what would you call them? Introduce the concept of renewable resources here.
3. What happens when fossil fuels are burned? Introduce CO2 and explain that it is released when fossil fuels are burned. Explain the consequences of increasing the levels of CO2. [For a deeper introduction to CO_2 and climate change, consider using Lesson 2 of *Next Generation Climate* or Lesson 4 of *Minnesota's Changing Climate*.]In their small groups ask the students to rank the energy sources in order of the amount of CO2 emissions they think they release from the most to the least, listing them on a sheet of paper. Once they have done this, ask them to rank them in order of monetary cost, from most to least. Did their lists turn out the same or different?
4. Show the two figures showing energy sources and their greenhouse gas emissions and energy sources and their relative monetary cost to the students and interpret them together. With younger students you may want to show them figures, but then tell them the order. Ask the students to check and see how their energy source CO2 and cost predictions worked out.
5. Show the two figures on page 40 showing energy sources and their greenhouse gas emissions and the list of energy sources and their relative monetary cost on page 41 to the students and interpret them together. As a class, rank each energy source by CO2 and by cost. Discuss whether you would include other "costs" when making a decision about energy source they might use.

Activity: Energy Pros and Cons, Grades 3-5 & 6-8

Teaches more about fossil fuels and the pros and cons of all energy sources.

Materials:

Classroom board

Instructions:

In the last activity you began discussing the costs of using different energy sources. In this activity students will make a list in their notebook of at least one pro and one con of each energy source discussed while contributing to a master list on the classroom board.

1. Thinking back on the last activity and costs- ask the students how the students make choices or decisions. Cost might be one thing they think about, but are there are other factors? For example, if they are going to choose whether to bring a lunch or buy school lunch what things do they think about? Introduce the concept of pros and cons and list a few pros and cons of school lunch.
2. Hand out the blank energy sources pros and cons worksheet. Have students raise their hands and share the energy sources we have here in MN. Add each one to their blank table (see image included in this lesson).
3. After the list of sources is full, or nearly so, hand out copies of the Minnesota Energy Map showing all of the locations of Minnesota's energy sources to help add more information to the discussion and to help students think of other sources they may have missed.

4. Next, ask students to think together about one pro and one con for an energy source and add them to the board. Fill up all the info we know about each energy source. Your board may look like this:

EX: Some pros and cons that are acceptable (not a complete list).

Cons -	*Source*	*Pros +*
Only makes electricity when wind blows, bat mortality, some people don't like how they look	Wind	Many states have great wind potential, low pollution, renewable, fast growing job market, cheaper energy source
Non-renewable, fossil fuel, air pollution (Carbon dioxide, mercury and more), asthma/ respiratory problems	Coal	Cheap (inexpensive), relatively easy to extract and transport, provides stable electricity generation
Meltdowns, expensive to build, radiation, waste is dangerous, lack of desire to live near	Nuclear	Powerful, can be affordable (after a reactor is built and up and running, nuclear energy tends to be inexpensive), cleaner than coal or natural gas
Exhaust smoke pollutes, fossil fuel, creates greenhouse gases when burned, risk of oil spills, non-renewable	Oil	Moves our cars and buses (not often used for electricity), jobs in USA, relatively cheap
Only makes electricity when sun shines, certain types be expensive (but getting cheaper), panels require rare and expensive materials	Solar	Provides electricity when we use it most (daytime), can put on homes and schools to save money, adding batteries adds power at night, growing job market
Can pollute, cause deforestation, more expensive than some fossil fuels	Biomass	Renewable, trees grow back, less carbon pollution than fossil fuels
Harvested through controversial hydraulic-fracturing processes (aka "fracking"), fossil-fuel, non-renewable	Natural gas	Burns cleaner than coal, domestic, some see it as a "bridge" technology between coal, oil, and cleaner renewable energy sources
Can disrupt aquatic and shoreline ecosystems and habitats, changing the river flow with dams can cause issues downstream such as drought	Hydroelectric	No polluting emissions, renewable energy supply, no fuel costs, provides stable electricity generation

Note: As you add pros and cons, define and discuss renewable and non-renewable energy. Encourage students to use the words "renewable", "non-renewable", and "fossil fuels."

5. When students are finished adding pros and cons, and you have at least one pro and con for each source, reflect on the board. Ask students:
    a. Which of these energy sources are renewable? How do you know?
    b. Which are non-renewable? How do you know?

Final Notebook Reflection

Ask students to paste their table into their science notebooks. If they were going to choose one or a combination of energy sources to power their home, what would they choose? Ask them to write four sentences explaining their choice and how they included costs, pros and cons in their thinking.

Extension

Extension: Greenhouse Gases and Climate Change, Grades 6-8

Consider watching this short film that goes over the basics of climate change and gets into the complexities of greenhouse gas air pollution, the greenhouse effect and our connection to it:
Online Video: "Piecing together the temperature puzzle" (5:48 run time) – NASA (Recommended for Grades 6-8)

1. Before watching the video, explain to students:
    a. This is a brief video about climate change from NASA. Climate change is one of the many consequences of our energy use.
    b. During the video, I want to you to record (3) three notes in your science notebooks. These can be any facts that you learn from the video that catch your interest. Pay extra attention to the portion about fossil fuels and carbon dioxide.
2. After watching the video, ask students about climate change:
    a. What is climate change? What are people talking about when they talk about it?
    b. Can anyone explain it to the class? What is the evidence that NASA refers to in this video?
    c. Be sure the following content is discussed:
        i. Fossil fuels produce carbon dioxide when they are burned
        ii. Carbon dioxide captures the sun's energy as it enters and leaves the Earth's atmosphere, warming the surface of the planet (greenhouse effect)
        iii. The dynamics of the carbon cycle, and the facts about Minnesota's CO2 emissions explained in the Background Information section of this lesson.

VOCABULARY

Carbon dioxide (or CO2): A naturally-occurring, greenhouse gas in the Earth's atmosphere

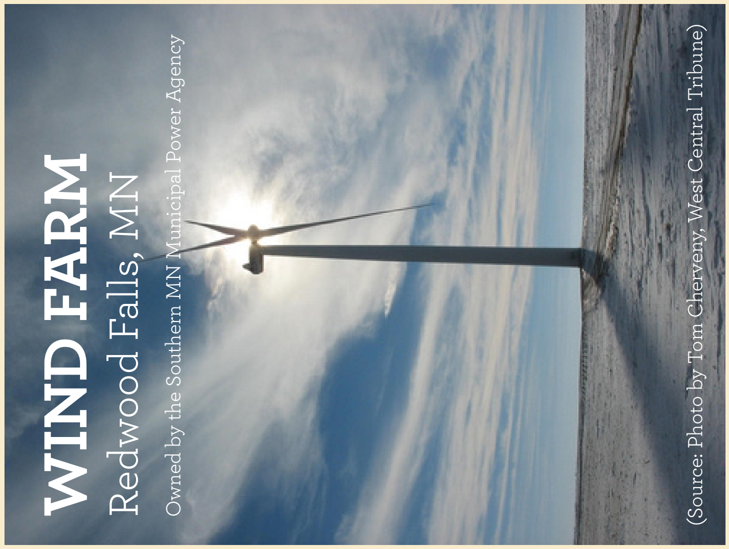
Climate change: The phenomenon of long-term changes to precipitation, temperature and weather patterns. Climate change can result from changing levels of greenhouse gases and other factors such as variations in the sun's output. This causes changes to the Earth's weather patterns including increasing the intensity of droughts, flooding, and storm activity.

Greenhouse gas: A type of gas that traps infrared heat from the sun that occur in the Earth's atmosphere.

Greenhouse effect: The phenomenon explaining the ability of the greenhouse gases to trap and reradiate infrared energy.

Non-renewable energy sources: Energy sources or carriers that are not replenished within our lifetimes (i.e. coal, which takes thousands of years to form naturally and can be burned in an instant)

Renewable energy sources: Energy sources that can be replenished within our lifetimes (i.e. wind, hydro, solar, biomass)


WIND FARM
Redwood Falls, MN
Owned by the Southern MN Municipal Power Agency
(Source: Photo by Tom Cherveny, West Central Tribune)


SOLAR FIELD
(Source: Saint John's University)
Collegeville, MN
Solar field land owned by St. John's Abbey
Solar panels owned by Westwood Renewables

WIND FARM

Pros: Clean, renewable energy source, can work 24 hours a day

Cons: Can kill migratory birds, some people don't like how they look

DID YOU KNOW?

- 18% of MN electricity comes from wind electricity generation
- MN ranks 12th in the country for renewable energy generation
- A group of wind turbines is called a "farm"
- The wind blows when the sun heats the land ... it is renewable and will blow as long as the sun shines

Sources:
US Energy Information Administration
Alternative Energy News

SOLAR FIELD

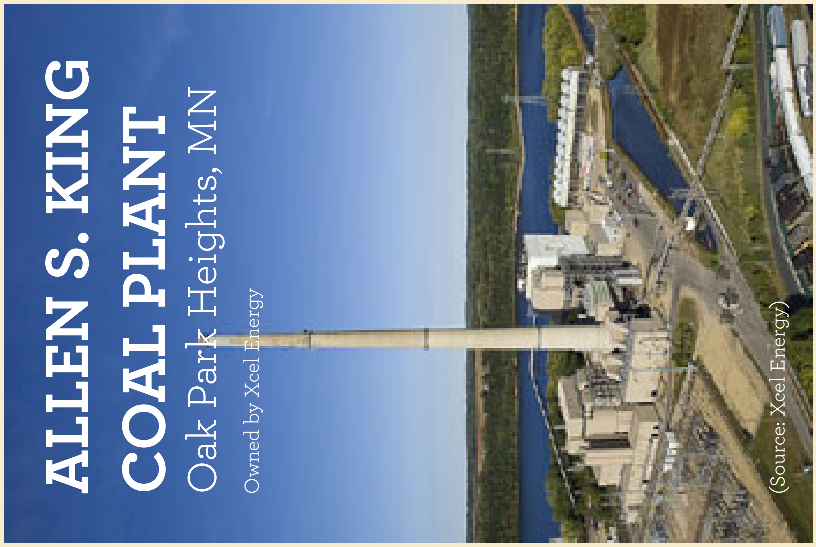
Pros: Clean, renewable energy source, works in day time when we need energy most

Cons: Panels require rare and expensive materials

Sources:
US Energy Information Administration
MN Solar Industries Association
Saint John's University
Fresh Energy

DID YOU KNOW?

- The solar farm at Saint John's will produce 2,855,000 kWh annually. This will account for 18.75% of Saint John's annual energy needs.
- The sun's energy can be used to make heat (solar thermal) or to make electricity (solar photovoltaic)
- Solar energy doesn't create any pollution or greenhouse gases
- MN has the same solar energy potential as Houston, Texas


ALLEN S. KING
COAL PLANT
Oak Park Heights, MN
Owned by Xcel Energy
(Source: Xcel Energy)


NUCLEAR PLANT
Monticello, MN
Owned by Xcel Energy
(Source: Xcel Energy)

COAL PLANT

Pros: provides stable electricity generation, fairly cheap (inexpensive)

Cons: Gives off greenhouse gases, nonrenewable energy source

DID YOU KNOW?

- All the coal burned in Minnesota comes from Wyoming
- The Allen King generates up to 511 Megawatts, 24 hours a day, 7 days a week
- The 785-foot tall smokestack includes a box so peregrine falcons can nest on it

Source: Xcel Energy

NUCLEAR PLANT

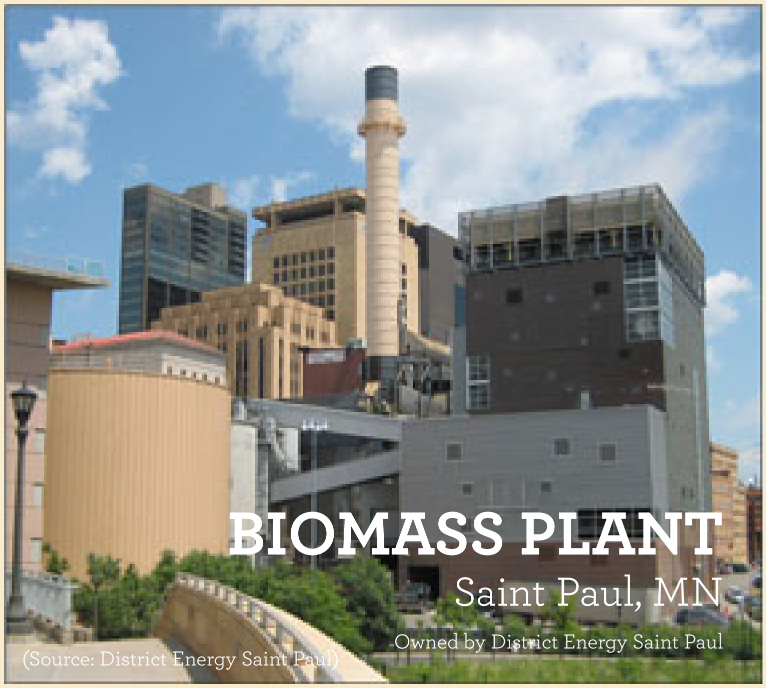
Pros: No harmful emissions, generates high amounts of energy

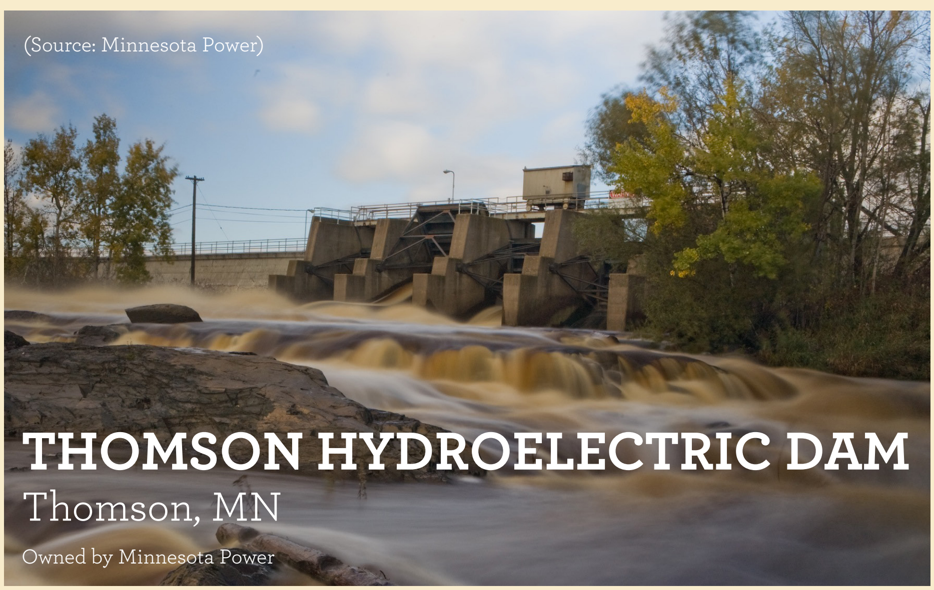
Cons: Radioactive waste is difficult to store and manage, possibility of meltdown

DID YOU KNOW?

- The nuclear plant in Monticello stores spent fuel within a storage area on site
- Nuclear plants work by a process called “atomic fission”

Source: Xcel Energy


BIOMASS PLANT
Saint Paul, MN
Owned by District Energy Saint Paul
(Source: District Energy Saint Paul)


(Source: Minnesota Power)
THOMSON HYDROELECTRIC DAM
Thomson, MN
Owned by Minnesota Power

BIOMASS PLANT

Pros: Burns renewable wood scraps from Minnesota mills

Cons: Can pollute, can lead to deforestation

Source:
US Energy Information Administration

DID YOU KNOW?

- "Biomass" technically refers to any living or once-living material, like wood
- Trees take in CO_2 during their lifetime. This is the only CO_2 they release when burned, so many consider them "carbon neutral"

HYDROELECTRIC DAM

Pros: Clean, renewable energy source, works in day time when we need energy most

Cons: Expensive energy source to operate, and can lead to ecological changes to river

Sources:
Chinese National Committee on Large Dams
Minnesota Shoreland Management Reference Guide

DID YOU KNOW?

- The largest hydroelectric dam in Minnesota generates 72 megawatts of electricty
- The largest hydroelectric dam in the world is the Three Gorges Dam in China, which generates over 22,500 megawatts


NATURAL GAS PLANT
Dexter, MN
Owned by Great River Energy
(Source: Great River Energy)


OIL PLANT
Solway, MN
Owned by Otter Tail Power Company
(Source: Otter Tail Power Company)

NATURAL GAS PLANT

Pros: Cleaner than coal and oil, less greenhouse gas emissions

Cons: Fossil fuel, nonrenewable, greenhouse gas emissions

DID YOU KNOW?

- Because natural gas is odorless and colorless, mercaptan is added to make it smell like sulfur (rotten eggs) so you can smell if it is leaking
- Most of the natural gas we use in the United States is captured in wells within the United States

Source:
US Energy Information Administration

OIL PLANT

Pros: Small and able to help in case of emergency energy demand

Cons: Expensive fuel source, fossil fuel, greenhouse gas pollution

DID YOU KNOW?

- Because fuel oil is so expensive in Minnesota, it is usually only used as an emergency source for plants like this one
- The Solway plant (pictured) is capable of burning oil or natural gas as necessary

Source:
Otter Tail Power Company

STOP 1: RESOURCE EXTRACTION/ TRANSPORTATION

In Minnesota we get our energy from a number of different sources including: coal, oil, natural gas, nuclear, hydroelectric, wind, solar and biomass. Coal is mined from the ground as is the Uranium used for nuclear power. Oil and natural gas are captured in wells. Biomass (wood) is often scraps collected from wood mills. The sun can be captured whenever it shines, the wind whenever it moves and rivers whenever they flow (for hydroelectric dams). This is where the journey of our energy supply begins.

Q: Which of these energy sources must be transported farthest to Minnesota?

(a) Coal (b) Wind (c) Natural gas (b) Biomass

STOP 2: POWER PLANTS/TURBINES

Power plants come in many forms – but most create electricity the same way: they spin a turbine. Turbines contain magnets that release electricity when they rotate near magnetic metal. Most power plants use their energy source to create heat. The heat boils water, creating steam, that spins the turbine. Wind and water can also move a turbine. Solar panels that create electricity are called "photovoltaic". They don't need a turbine, they use a chemical reaction that reacts to sunlight instead.

Q: Which of these things is used to spin a turbine in a coal plant?

(a) Steam (b) Wind (c) Rivers (d) The Sun

STOP 1: RESOURCE EXTRACTION/ TRANSPORTATION

Answer: (a) Coal travels 400 miles from Wyoming to Minnesota. Natural gas is collected as near as North Dakota, biomass is collected in northern and southwestern Minnesota and the wind ... well, we don't have to transport it at all!

MOVE FORWARD 40 STEPS

Sources: Xcel Energy, US Energy Information Administration

STOP 2: POWER PLANTS/TURBINES

Answer: (a) steam is created by burning coal to heat water. The movement of this steam is used to turn a turbine and create electricity.

MOVE FORWARD 25 STEPS

Source: Mary Bauer

STOP 3: TRANSFORMERS

Transformers **raise** the voltage of the electricity to prepare it for long-distance, high-voltage transmission. Electricity can be transferred more efficiently at high voltages. Transformers also **reduce** the voltage to prepare electricity for local, low-voltage distribution.

Q: Among the 50 United States, where does Minnesota rank for how much wind energy we produce (in 2011)?

(a) 40th (b) 24th (c) 13th (d) 8th

STOP 4: TRANSMISSION

Next the electricity is transported – sometimes hundreds of miles – using high-voltage transmission lines. These lines stand 180 feet tall and carry electricity charged to 400,000 volts.

Q: In the US, what sector uses the most energy?

(a) Residential/homes (b) Industrial/factories
(c) Commercial/stores (d) Transportation

STOP 3: TRANSFORMERS

Answer: (d) 4th! In 2017 we produced 10.9 mWh (an increase of 62% from 2011)

MOVE FORWARD 2 STEPS

Sources: US Energy Information Administration, California Energy Commission, Glogger via Wikimedia commons

STOP 4: TRANSMISSION

Answer: (b) Industrial/factories use around 32% of the energy produced in the US. Transportation is in 2nd place (29%), residential is 3rd (21%) and commercial is 4th (19%) in terms of national energy use.

MOVE FORWARD 15 STEPS

Sources: US Energy Information Administration. *Monthly Energy Review*, April 2017.

STOP 5: LOCAL DISTRIBUTION

Now we're getting close to home. These low-voltage local wires are what we see right here near our houses and schools – look up! These stand 50-70 feet high and carry electricity charged to 69,000 volts.

Q: What portion of energy used by an incandescent lightbulb is used to actually make light?

(a) 100% (b) 97% (c) 75% (d) 10%

STOP 6: WE HAVE ARRIVED!

Finally the energy carried in that electricity arrives at your school or home – we use it everyday to power electronics of all kinds. The energy comes into the house, gets used and ... then what?

Q: Where happens to energy go after it is used?

(a) It disappears (b) It becomes pollution
(c) Nothing (d) It changes forms

STOP 5: LOCAL DISTRIBUTION

Answer: (d) 10%. 90% of the energy used by a lightbulb is used to produce heat. By contract, an LED light bulb makes light with 80-90% of the energy it uses and this is why it is more efficient.

MOVE FORWARD 4 STEPS

Source: https://www.iup.edu/energymanagement/howto/led-lighting-benefits/

STOP 6: WE HAVE ARRIVED!

Answer: (d) it changes forms. Energy is never created or destroyed, it only changes forms. It is defined as a "quantity that passes from system to system" or from place to place and living thing to living thing.

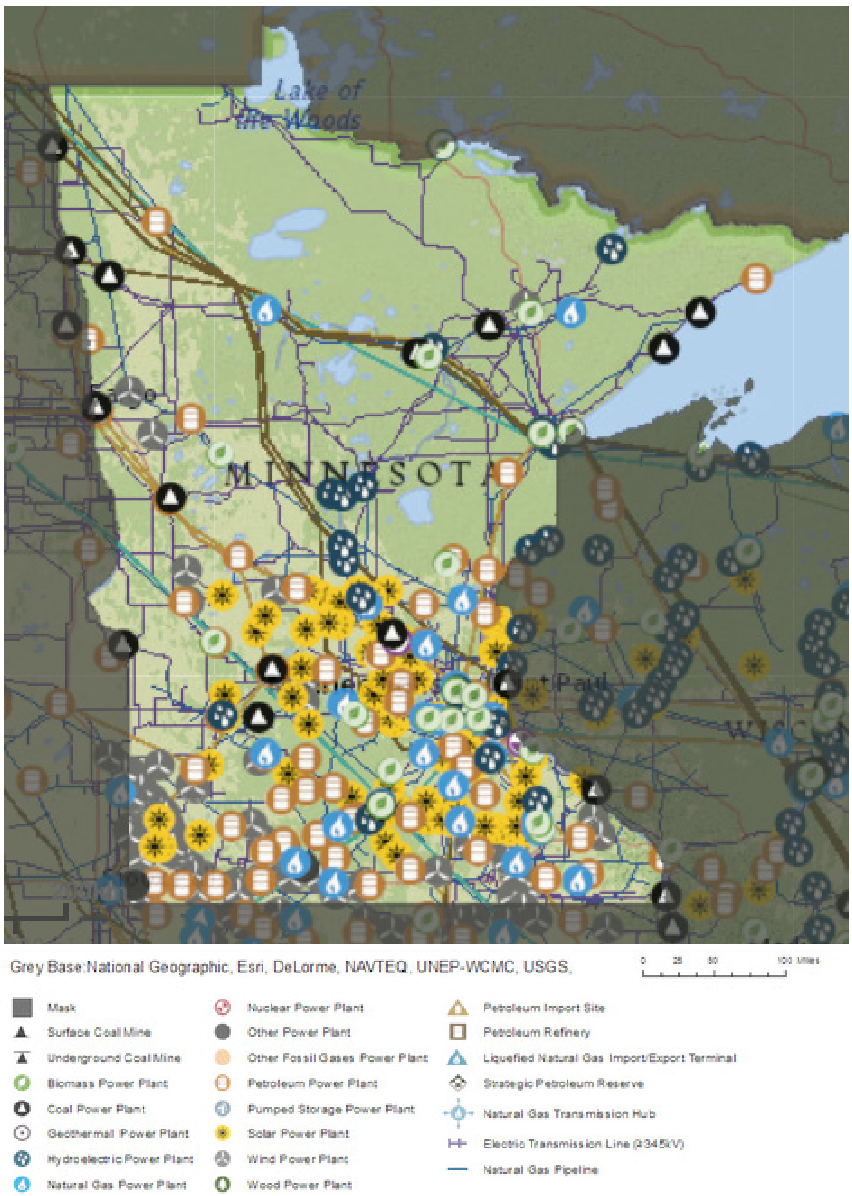
MOVE FORWARD 0 STEPS

Source: US Department of Energy

Minnesota State Energy Map

This map takes a different approach, showing icons for all major energy plants within the state, including: coal, natural gas, oil, nuclear, biomass, wind and solar.

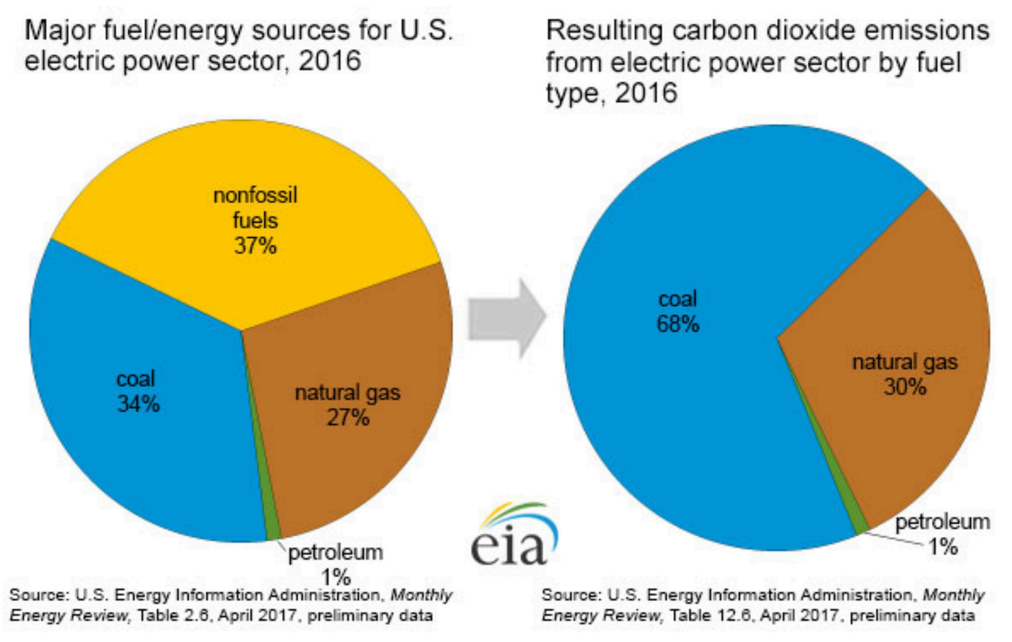
(Note: The map is available as an interactive tool, allowing you to change what information is shown, online at the US Energy Information Administration's webpage: https://www.eia.gov/state/?sid=MN)



Source: US Energy Information Administration

US CO2 Emissions Source Related to Electricity Generation

Energy source for US Electric Power Sector and Resulting CO2 Emissions



Source: Energy and Environmental Explained: Where do Greenhouse Gases Come From
https://www.eia.gov/energyexplained/index.php?page=environment_where_ghg_come_from

Economics of Energy

COMPARING THE COST: NEW ELECTRICITY SOURCES

What's the price of new power? Comparing the levelized costs of new electricity resources on a per megawatt-hour basis shows that effciency comes out on top.

$21-$23
Energy Efficiency

$30-60
Wind Energy

$42-78
Natural Gas (advanced combined cycle: a more efficient process)

$42-$53
Solor Photovoltaic - Utility Scale

$60-$143
Coal

$74-$114
Biomass

$76-$150
Solor Photovoltaic - Community

$82
Solor Photovoltaic - Utility Scale with battery

$87-$145
Natural Gas (advanced combustion turbine: a less efficient process)

$112-$183
Nuclear

$187-$319
Solar Photovoltaic – Rooftop Residential

Data: Lazards's Levelized Cost of Energy Analysis — Version 11.0 (2017) https://www.lazard.com/media/450337/lazard-levelized-cost-of-energy-version-110.pdf
Levelized Cost and Levelized Avoided Cost of New Generation Resources in the Annual Energy Outlook 2018 (March 2017). https://www.eia.gov/outlooks/aeo/pdf/electricity_generation.pdf

* The price of solar is decreasing rapidly and will be cost-competitive in a few years.
Whether nuclear can be competitive is uncertain.

Energy Source Pros and Cons

Cons -	Source	Pros +

Lesson 3: How do we use energy in our classroom?

"We use energy everyday at school and at home"

Age Level:	Grades 3-8
Time Needed:	45-60 minutes
Materials:	Kill a watt meter(s) School Energy Audit worksheet Classroom board or large sheet of paper Science notebooks Items from home to test, including small appliances, chargers, nightlights, etc.
Student Learning Outcomes:	Students will be able to perform a simple evaluation of a built environment like a school or home for energy use and make recommendations for easy improvements Students will be able to define kilowatt-hour (kWh) and watt Students will be able to convert daily energy usage into daily CO_2 and daily cost and to forecast the three over the course of one week, and one year.

Background

Now that students have become aware of energy and its complexity, it's important to differentiate between energy and electricity. Electricity, remember, is not a source of energy, but a "carrier" of energy. However, electricity is commonly thought of as a synonym for energy because it is the most recognized carrier of energy.

Electricity use is measured in kilowatt-hours (kWh). This is the number that your electricity provider measures when they decide to send your electrical bill. It stands for "the number of kilowatts of electricity used for one hour." A kilowatt is a measure of available power or potential rate of energy production or consumption. Kilowatts multiplied by hours of use= energy consumed.

Vampire energy is a term to describe how some devices use energy while turned "off," or are not in use. This is especially true of electronics that automatically go into a "stand-by" mode when turned off so they can be easily turned on again. An example of this is a TV that is remote-controlled. In order for the remote to turn "on" the TV it has to be sensing for the signal of the remote, which takes electricity. It's off, but it's essentially on too!

This lesson is primarily an audit of everyday energy use. An energy audit is an investigation of your home, school or workplace that helps you determine where you are losing energy so that you can develop recommendations on how to be more efficient. Students will explore their surroundings within the classroom to discover just how much energy gets used and what for. Making the connection between energy use and the activities around pros and cons and cost in Lesson 2 will help build the bridge between our everyday energy choices and the consequences of those choices.

Note: The Kill A Watt Meters we will reference in this lesson are a product from P3 International. They can be purchased at many local electronics stores or online at retailers such as Home Depot, Amazon or similar. Also, some public library systems carry them to be checked-out just like books.

How, when, and in what form we use energy can have a dramatic effect on our lives, our bank accounts, and our environment. Using energy wisely makes sense and is a goal that we can all share.

—Minnesota Department of Commerce Division of Energy Resources (energy.mn.gov)

Notebook Assignment

At the end of this lesson, student notebooks should include predictions and details about their energy audit findings as well as, definitions of the following by way of a conversion table activity:
Kilowatt (kW)
Kilowatt-hour (kWh)

Activity Description

Introduction Activity: Classroom / School Energy Audit, Grades 3-5 & 6-8

Reflect on the pros and cons discussed in Lesson 2 and evaluate energy use at your school.

Materials:

Kill a Watt meter(s)
School Energy Audit worksheet
Classroom board or large sheet of paper
Small appliances, chargers, nightlights and other familiar energy users from home

Instructions:

1. Introduction:
    a. Ask your students to make predictions or guesses about where they use energy around school and write them in their notebooks. What things use the most? What things use the least?
    b. Ask the students to think about places where energy, such as heat, might be lost or escape. Where might the most be lost? Remind students that the energy isn't destroyed, it is simply lost in the form of heat or light.
    c. Introduce the concept of vampire energy if students do not bring it up themselves.
    d. Introduce the concept of audits as investigations of a particular space to determine how and where energy is used.
2. Next, split students into groups of 2-4 individuals. Each group will receive one School Energy Audit worksheet and a Kill A Watt meter, and will need a writing utensil.
3. To do the audit, groups need to choose a room to review. Perhaps your classroom is best, or maybe you can divide your students up into neighboring rooms as well. It is best if groups are encouraged to spread out from one another.
4. Discuss their findings recorded in the worksheet.
    a. What item, of everything tested, uses the most energy?
    b. How do our findings compare with our predictions?
    c. What was one thing that surprised you?
    d. What new thing did you learn about the room you audited that you didn't know before?

Activity: Energy Audit Conversion Table, Grades 6-8

What's the difference between a watt and a kWh? Use this unit conversion activity to learn the lingo of energy pros and analyze some of your audit results to better understand their value.

Materials:

What's the cost of energy use? worksheet

Instructions:

1. After entering audit data into your worksheet, use that information to complete the following unit conversion activity as a group, in small groups or individually.

2. After they finish, discuss what they learned from this. Looking over their findings, what are their initial conclusions? What might be a useful way to share this information? (Student will create graphs using this data in Lesson 4.)

Take it Outside

Activity: External Energy Audit

For the energy audit, take students outside to explore what can be learned about the energy use of the building from the outside.

1. Stop at a few different locations to observe windows, equipment, doors, lights, etc. Inspect areas where two different building materials meet for insulation, caulking, or cracks, including: all exterior corners, outdoor water faucets, where siding and chimneys meet, areas where the foundation and the bottom of exterior brick or siding meet.
2. Ask students to record in their notebooks three places they see energy being lost.

Final Notebook Reflection

When you think about your electricity use at home, what do you think would be interesting to measure? What do you think uses the most electricity in your home or room?

Extension

Consider asking each student to calculate their "carbon footprint" using a credible online calculator. You can find a variety of options to choose from at:

http://www.climategen.org/climate-lessons-blog/item/1175-carbon-calculators-reviewed

Ask students to find out how many kWh they use per month in their home. They can find out by looking at their energy bill.

VOCABULARY

Energy audit: An evaluation or survey of energy use.

Kilowatt (kW): A unit of electricity, equivalent to 1,000 watts

Kilowatt-hour (kWh): A unit used to describe energy used over time, e.g., one 100-watt light bulb uses .1 kilowatts per hour or .1kWh. Commonly, energy users are charged by the number of kWh they use each month from their electricity provider.

Vampire energy: Energy used by a device when not in use (e.g., a computer plugged in, but not turned on).

School Energy Audit

What are the energy needs of your school? Choose one room (or more) and explore the usage of energy in that place.

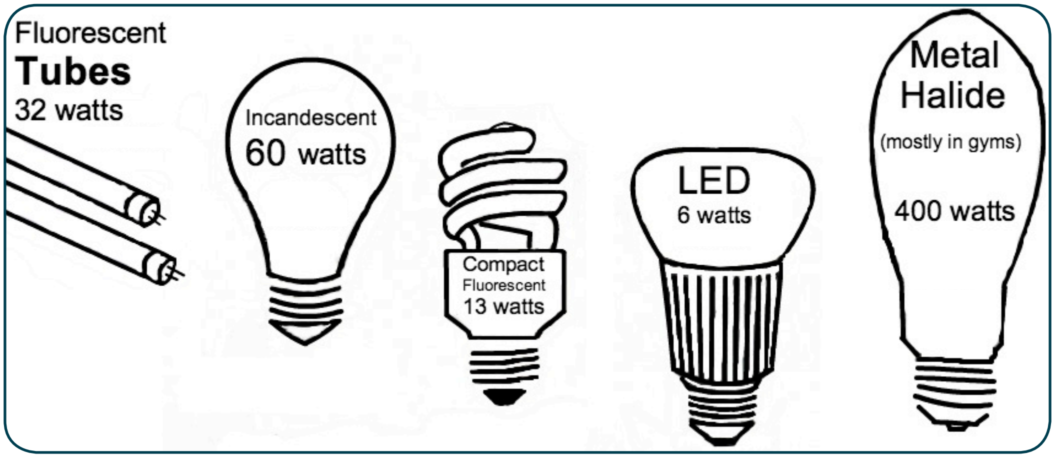
Names: _________________________
____
____

Room Audited: ___________________
Class Period: _____________________

LIGHTING

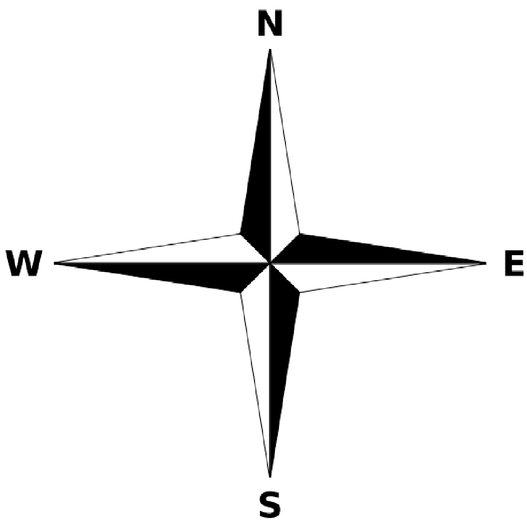
How many light bulbs or light tubes do you find?	A
How many hours are the lights ON each day? (you may need to estimate)	B
Find the type of light pictured below and enter the amount of energy it uses (watts) here	C
Find the total energy used by the lights using this equation: A x B x C =	Total energy used for lighting (Watts/hour) A x B x C =

Which light is it?



WINDOWS

Number of windows	
How many layers of glass do they have? (1 or 2)	
Feel closely: Do you notice a draft near the edges of the window? (yes or no)	



Which direction are the windows facing? (Circle one in the picture at left.)

Did you know?

The sun rises in the east and sets in the west. We get the most sunlight from the south and have the most shade on the north side of homes, buildings and trees.

APPLIANCES

Test things that use electricity with the Kill A Watt meter

Name of item	kWh used when turned **ON**	kWh used when turned **OFF = vampire energy!**

Did you know?

***Vampire energy** happens when something uses energy when it is turned OFF!*

What's the "cost" of energy use?

Write the missing information into the tables that follow to find the impact of your classroom's energy use.

Names: _________________________
____
____

Equations are in bold	Watts (W)	Kilowatts (kW) **Watts / 1000**	# hours this appliance is on each day	Kilowatt hours (kWh) **kW X hours**	Daily Cost ($) **kWh X $.12**	Daily CO_2 emissions (lbs CO_2) **kWh X 2**
Example Appliance	100 watts	100/1000 = .1 kW	8 hours	.1 X 8 = .8 kWh	.8 x .12 = $.10	.8 X 2 = 1.6 lbs
Appliance #1:						
Appliance #2:						
Appliance #3:						

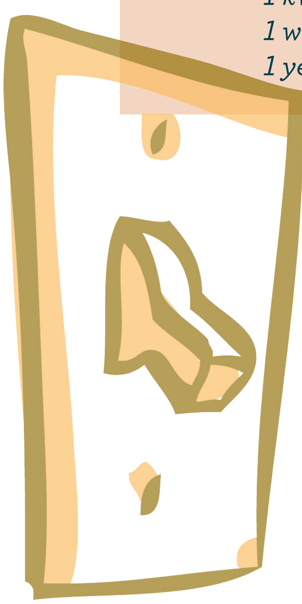
For further exploration, see what this information amounts to over time using these conversion tables:

Equations are in bold	Daily cost (see above) **1 day**	Cost per week **1 day X 7 days**	Cost per year **1 day X 365 days**
Example Appliance	$.10	.10 X 7 = $.70	.10 X 365 = $36.50
Appliance #1: dollars spent			
Appliance #2: dollars spent			
Appliance #3: dollars spent			
Total dollars spent			

Equations are in bold	Daily CO_2 emissions (see above) **1 day**	CO_2 emissions per week **1 day** **X** **7 days**	CO_2 emissions per year **1 day** **X** **365 days**
Example Appliance	1.6 lbs	1.6 lbs X 7 days = 11.2 lbs per week	1.6 lbs X 365 days = 584 lbs per year
Appliance #1: CO_2 emissions			
Appliance #2: CO_2 emissions			
Appliance #3: CO_2 emissions			
Total CO_2 emissions			

Conversion table values and sources:

1 kW = 1000 watts
1 kWh = 1000 watts, used for one hour
1 kWh = 2 lbs of CO_2 (source: Energy Information Administration)
*1 kWh- $.126 (or 12.6¢) (National Average as of Feb 2018)**
1 week = 7 days
1 year = 365 days



** For the specific cost of electricity in your state: https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a*

Lesson 4: What are conservation and efficiency solutions?

"Efficiency and conservation help us use energy in smarter ways"

Age Level:	Grades 3-8
Time Needed:	45-60 minutes
Materials:	Graph paper (optional) Writing utensils Colored pencils, crayons or markers Rulers (optional) 1-2 liters of water 2 plastic cups (1 with a hole in the bottom) 1 paper towel or napkin A towel Science notebooks
Student Learning Outcomes:	Students will be able to use and define the words *conservation* and *efficiency* as they relate to energy behaviors Students will be able to create charts using data from the previous lesson and assess the results Students will be able to prioritize efficiency and conservation decisions they can make in their own lives

Background

Now that we know the consequences of using energy and of certain energy sources, as well as where and how we use energy, the next 3 lessons all focus on solutions. Lesson 4 is a hands-on exploration of **energy efficiency** (optimizing use of energy; wasting less) and **conservation** (foregoing use of energy; unplugging or turning off things that use energy).

"Energy efficiency is an energy resource, just like wind or coal."
—Fresh Energy
http://fresh-energy.org

Energy efficiency and conservation are commonly regarded as the cheapest ways to lessen the negative impacts of our energy choices. According to the Center for Energy and the Environment, "Efficiency is the least expensive way to mitigate carbon—in fact, it saves money. Minnesota's efficiency efforts avoid CO_2 at an approximate cost to society of minus $30 per ton." Efficiency actions include turning off your lights when not in use and adjusting your thermostat so the air conditioning system works less when you are out of the house.

For some in disaster scenarios—like in our Energy Conservation & Spectrum Game Activity—being efficient with, and conserving energy are a part of survival. For most of us in the U.S., these are just smarter ways of doing things, to waste less and save money.

Notebook Assignment

At the end of this lesson, student notebooks should include graphs of their audit data, lists of their household energy use (and conservation priorities) and definitions of the following:

Conservation

Efficiency

Activity Description

Activity: Energy Efficiency Introduced (20 min.), Grades 3-5 & 6-8

Engaging in discussion on efficiency through a hands-on water demonstration

Materials:

1-2 liters of water
2 plastic cups (1 with a hole in the bottom)
1 paper towel or napkin
A towel

Instructions:

After the graphing activity, students will have an understanding of how much each appliance used. But, why do some use more than others? And what's so different about all those types of lights? This activity explores efficiency using water as a metaphor for energy.

1. Preparation note: Decide where you would like the demonstration to take place and set the towel there as well to catch water. This could take place over a table or simply over a section of noncarpeted floor. We recommend a table if possible.
2. Have two-three students stand at the front of the room and hold out their hands. Explain that you are going to give them some water to hold on to, and that they might get a little wet (let them opt out if this is a big concern).
3. Fill each person's hands with water and tell them to hold it as long as they can. It is a race ... sort of: a contest of who can hold the water the longest. Time the students for a little "data" and fun. If someone thinks they can keep going, why not let them go so long as they don't distract everyone.
4. Process the experience:
    a. Was the last group successful?
    b. We will try again but this time—get some new volunteers—who thinks they can hold it longer?
5. The next group has the same challenge except they get upgrades—one gets a cup, the next gets a cup with hole in it, the third gets a towel to hold their water.
6. Ask students:
    a. What do they expect to happen? Who will win? Why?
    b. What other upgrades could we try? Feel free to adjust and try another upgrade or two if you have time during this round.
    c. This game with the water is important because it illustrates "efficiency" ... but how? Who can define the word *efficiency*?
    d. The task was to hold in the water, what was the most efficient way of doing so?
    e. How does this apply to homes, energy use and appliances? (imagine that your insulation in the walls is like that cup, carrying, holding heat in the winter and containing cool air in the summer ... some appliances also, by their designs, leak energy or use it less wisely than others).
7. Write *efficiency* on the board and work out a definition together—ideal definitions are similar to "using as little energy as possible to do something" or "not wasting energy."

Activity: Visualizing and Evaluating Audit Results, Grades 6-8
Interpret the survey data, and create graphs to visualize.

Materials:
Graph paper (optional)
Writing utensils
Colored pencils, crayons or markers
Rulers (optional)

Instructions:
Graph the kWh, carbon dioxide and cost data from the Home Energy Audit activity in lesson 3 to make the results more visual. Depending on your students' comfort and skills with making graphs you can make them individually or as a group. Students should add these two graphs to their notebooks:

1. Pie chart: Of all the appliances you measured the energy use of (or carbon emissions or cost), what portion does each individual appliance use? Add up the total of all the appliances and find out what percentage of the total each appliance is responsible for. It may be easiest to limit to 10, 5, or even 3 appliances for comparison and to make this age/ability appropriate.
2. Bar graph: Graph the energy use, carbon dioxide emissions or cost of using all or some of the appliances measured. You may choose to draw them in order of lowest-highest usage, or color them by what room they are found in the school, or use other categories too.
3. Ask the different groups to trade graphs with another group, and in their small groups, ask them to come up with three things each graph communicates.
4. Share findings as a class and discuss how these findings are useful.
5. Ask students to create a report that provides recommendations of where they can be more efficient in the classroom.
6. As an alternative to this activity, ask the students to do research on some of their own favorite appliances and make a graph comparing different types of televisions, or other appliances.

Take It Outside

Activity: Energy Conservation & Spectrum Game (25 min.), Grades 3-5 & 6-8

Decide which energy uses are most important to you and your family

Materials:

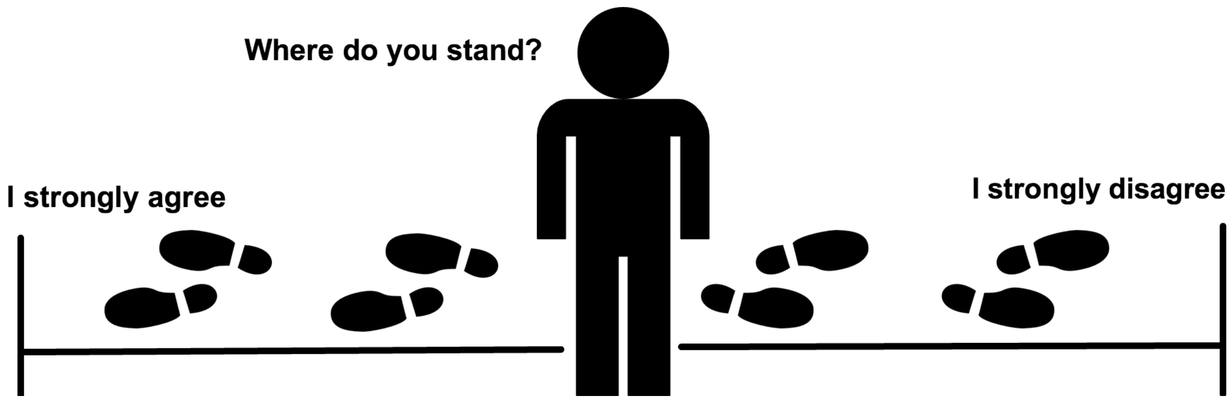
1 sheet of notebook paper
Writing utensil

Instructions:

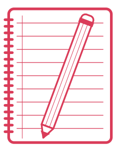
1. On a sheet of notebook paper, have students list at least 10 ways they and their family use energy around their house.
2. Once complete, share with them the following, completely fictitious story:

    "I have a friend who lived through an ice storm in northern Minnesota in 2009. Rain fell and froze the moment it hit any surfaces. Ice coated everything more than an inch thick. Trees fell and broke power lines all around their area and everyone immediately lost electricity to their homes and businesses. No lights, no phones, no radio, etc. Luckily, their neighbors had a generator that could supply electricity to their house—but they had to charge 5X more for the energy because it was so hard to get. Also, the generator was only strong enough to power 2 things at once. It would be 5 days before electricity would come back to normal. They had to make some tough decisions...

3. What would you do? Look at your list and, perhaps with a partner, make some decisions about how you will conserve energy. After a few minutes, have students share with the group any decisions they would make.
4. Collect all of the lists and prepare the group to go outside for 15 minutes.
5. Once outside, have all students get in a line, shoulder to shoulder from tallest to shortest or by birthday, if they need something to help them focus.
6. Once in a line, or close to one, establish a clear beginning and end of the line segment—imagine it as a spectrum where all students can fit and arrange themselves depending on their responses (see diagram).



7. Next, explain that the students now stand on a spectrum: from "strongly disagree" on one side to "strongly agree" on the other side. Explain which end of the spectrum is which. In a moment, you will read a statement out loud and students have to move to where they stand on the spectrum, whether they agree or disagree, or if they strongly agree or disagree, and move to that spot on the spectrum.
8. You will then complete the sentence: "If I had to conserve, I would not use the (insert item from a student's list here." Encourage students to move and to be prepared to justify their answers.
9. Now, read a few of the list items the students wrote, in sentence form as expressed above (do about 10 total). After each one, you can poll the group:
    a. "Why are you standing where you are?"
    b. "[insert name of student] you are the only one who agrees—can you share with us why you chose that spot?".
10. Consider telling students to turn to their neighbors and discuss with them why they decided to stand where they are.



Final Notebook Reflection

Now that students know what things in their lives they are most and least willing to change, have them make a pledge in their science notebook to do something that conserves energy or uses it more efficiently.

VOCABULARY

Conservation: Foregoing the use of something.

Efficiency: Using less to get desired outcomes.

Lesson 5: What are renewable energy solutions?

"Renewable and nonrenewable energy resources"

Age Level:	Grades 3-8
Time Needed:	45-60 minutes
Materials:	MN Energy Maps Science notebooks ... Many other materials are possible and listed in the individual engineering projects in this lesson
Student Learning Outcomes:	Students will be able to use solar or wind energy to accomplish basic tasks of heating a food item and lifting pennies Students will be able to define qualities of a well-engineered renewable energy project Students will be able to explain which regions of Minnesota are best suited for certain renewable energy projects and why

Background

What makes some energy sources "renewable" while we consider other sources "nonrenewable"? The difference between renewable and nonrenewable energy is a matter of time. Renewable energy sources, like wind, the sun and rivers, are easily classified as renewable because they can potentially provide energy everyday into the indefinite future. They will only stop producing when the sun burns out or the river runs dry. Biomass (remember: wood or plant material or animal waste) is also considered renewable as it is relatively quick to be produced or grown.

Nonrenewable energy, such as fossil fuels, cannot be reproduced in our lifetime to any significant degree. The US Department of Energy explains that fossil fuels took millions of years to form deep beneath the earth's crust under heat and pressure.

> *"Minnesota's Renewable Energy Standard (RES) is one of the nation's strongest renewable energy standards, requiring utilities to provide 25 percent of their total electrical generation from renewable sources like wind, hydrogen and solar power by the year 2025 and will help create next-generation industries with high-quality, good-paying jobs for Minnesotans."*
>
> *—MN Renewable Energy Gateway (found at: http://www.renewable.state.mn.us/)*

Notebook Assignment

At the end of this lesson, student notebooks should include preliminary designs—and possible redesigns—of their solar oven and/or windmill.

Activity Description

Activity: What about renewable energy in Minnesota?, Grades 6-8

Introduce students to renewable energy "potential" in Minnesota.

Materials:

MN Energy Maps (found at the end of this lesson)

Instructions:

1. Show the maps and discuss the potential for renewable energy in Minnesota.
2. Review wind, solar and biomass and what each entails.
    a. Wind turbines are where wind spins blades which turn a turbine and make electricity. (note: this is different from a windmill, which uses the wind's energy to accomplish physical work, like grinding grain in a mill. That is what they were originally used for. Hence: windmill.)

b. Solar Photovoltaic cells—what we usually call solar panels—produce electricity through a reaction between the sun's light and the chemicals within the "cell."
c. Biomass means, literally, any mass that was living. Trees, grass, leaves, corn stalks all are biomass. It is burned to make electricity, through an essentially similar process to coal (burning the material boils water, creating steam, which rises and turns a turbine to make electricity).

3. Looking at the maps provided, and assuming they have as much money as they want, ask the students to draw their own plan for renewable energy in the state of Minnesota. Ask:
    a. Where would be the best place to put wind turbines? Solar? Biomass plants?
    b. What other things besides money should be considered?
    c. Are there other costs or benefits to putting a biomass plant in a community or a wind turbine in a field?

Activity: Renewable Energy Engineering Projects (grade levels vary)
Choose one or both of the following simple renewable energy projects that use engineering, design and inquiry skills.

Get ready for fun and save time for cleaning up messes at the end. You may choose to do multiple iterations of these projects for extra experimentation and to get refined products. Note: there are no right answers for how these should look—that's okay. Give students the freedom to really get creative as they try to solve these tasks!

Solar Oven Project, Grades 3-5 & 6-8
Engage students in building simple solar ovens that harness solar energy, showcase efficiency and are thoughtfully designed.

Materials:
(1) Roll of tin foil
(1) Kitchen-style thermometer
(3) Scissors
(8) Assorted cardboard boxes (pizza boxes work well and are available at your local pizza shop)
(5-10) Assorted metal cans (soda cans will work fine)
(10-20) Assorted glass and plastic containers
(1) Roll of duct tape
Something to cook. Any of the following work great:
    Several potatoes (halved)
    Ingredients for s'mores (graham crackers, marshmallows and chocolate)
    A bushel of apples (sliced in halves)
... Be creative! Any household art supply or material from the recycling bin will likely go to use!

Instructions:
Your school wants to build a solar oven and is interested in your design. They want an oven that:
    a. Is efficient at capturing heat
    b. Is affordable
    c. Looks aesthetically pleasing
    d. Is durable

The students' task is to construct an oven that heats up the food item as much as possible in a given amount of time, using the sun's energy outside, and to record their design ideas in their notebook. Also projects should be judged on the other design standards listed above (affordable, aesthetics, etc.)

(An example of a simple solar oven made with a pizza box and some foil.
Photo: Liz Heinecke, NASA Earth Ambassador)

1. First things first: have individuals look at the materials and draw a basic design of what their oven will look like. Pictures must include the sun—which direction is it shining from?
2. Divide students into groups of 2-3. Have them send someone to get some materials for the oven (it may be helpful to have them set out already on different tables). Each group gets the following materials (at most):
    a. 1 pizza box
    b. 3 feet of duct tape
    c. 3 feet of aluminum foil
    d. 3 plastic/glass containers
    e. 2 metal cans
    f. Other cardboard, metals or supplies that you provide
3. Give students 15-20 minutes to actually build and experiment with their ovens. When finished, have them take them outside and set them in a place where they can stay while they cook. Have the students record the following information in their notebooks:

	Outside air temperature (F)	Oven temperature (F)
At start:		
After 10 minutes:		
After 20 minutes:		
After 30 minutes:		

The cooking process can take 15-30 minutes. The point isn't to cook the food, necessarily, but to observe a change in temperature of the food over time.

4. While the food is cooking, and students are recording temperatures, be sure to take a tour of the different ovens and have each group answer the following questions to the class:
   a. What about your design makes it efficient at capturing heat?
   b. … makes it affordable?
   c. … looks aesthetically pleasing?
   d. … makes it durable?
5. As a final question, have students think about how these concepts could apply to their school or home.
   a. The school and an oven have very different purposes, but how could we consider the sun's energy when we design or change the school?
   b. Where in the world would a solar oven be most beneficial to use? (Consider that the closer you get to the equator, the more direct sunlight you get year-round.)
6. Be sure to have students help with the cleanup process (either during the cooking time or at the end).

Wind Mill Project, Grades 3-8
(adapted from PBS Teacher's Domain, "Exploring Windmill Design")

Engage students in building simple wind turbines that harness wind energy, showcase efficiency and are thoughtfully designed.

Materials:
1 pack of (25) 1 oz. paper cups
Pencils, enough for every student
Push pins, enough for every student
1 pack of index cards
Scissors
Tape
String
An electric fan (a big floor fan is best)

Instructions:
Your community wants to build a windmill and is interested in your design. They want one that:
   a. Uses the wind to lift pennies from the ground
   b. Is affordable
   c. Looks aesthetically pleasing
   d. Is durable.

The students task is to construct a windmill that lifts pennies from the floor, to record their design ideas in their notebook, and using the wind energy from either (1) a floor fan indoors (recommended for standardized experimentation) or (2) wind energy outside. Also, projects should be judged on the other design standards listed above (affordable, aesthetics, etc.)

1. First things first: have individuals look at the materials and draw a basic design of what their windmill will look like. Pictures must include the wind—which direction is it blowing from?

2. Divide students into groups of 2-3. Have them send someone to get some materials for the windmill (it may be helpful to have materials set out already on different tables). Each group gets the following materials (at most):
   a. 3 cups
   b. 4 pushpins
   c. 5 index cards
   d. 2 feet of string
   e. Tape as needed
   f. 1 pencil
   g. Other cardboard, metals or supplies that you provide
3. Give students 15-20 minutes to actually build and experiment with their windmills. When finished, have them make predictions and perform tests to see how many pennies their windmill can lift when the fan blows directly at the blades. Have them record the following changes in their notebooks, making note of design changes and how each change affected their penny-lifting:

3.

	# of pennies lifted	What did you change?
First design		n/a
First redesign		
Second redesign		

4. Once groups have tested their windmills and had the chance to make changes to their first design, have each group answer the following questions to the class:
   a. What about your design makes it efficient at capturing wind?
   b. ... makes it affordable?
   c. ... looks aesthetically pleasing?
   d. ... makes it durable?
   e. ... what is the relationship between the speed the blades turn and the number of pennies the windmill can lift?
5. As a final question, have students think about how these concepts could apply to their school or home.
   a. The school and an oven have very different purposes, but how could we consider the wind's energy when we design or change the school?
   b. Where in the world would a windmill be most beneficial to use? (consider what types of work you can do with a windmill, and that we get the most consistent wind on mountain tops, in prairies or at sea).
6. Be sure to have students help with the cleanup process.

Take it Outside

Both of the Renewable Energy Engineering Projects can be easily taken outside to test student projects. Additionally, the following activity can serve as a good bridge during project downtime (such as when you are waiting for an oven to warm up).

Final Notebook Reflection

In your notebook, answer the question:
If you were going to choose one form of renewable energy to use for your school, which one would you choose and why? Use the Minnesota energy maps as a reference.

VOCABULARY

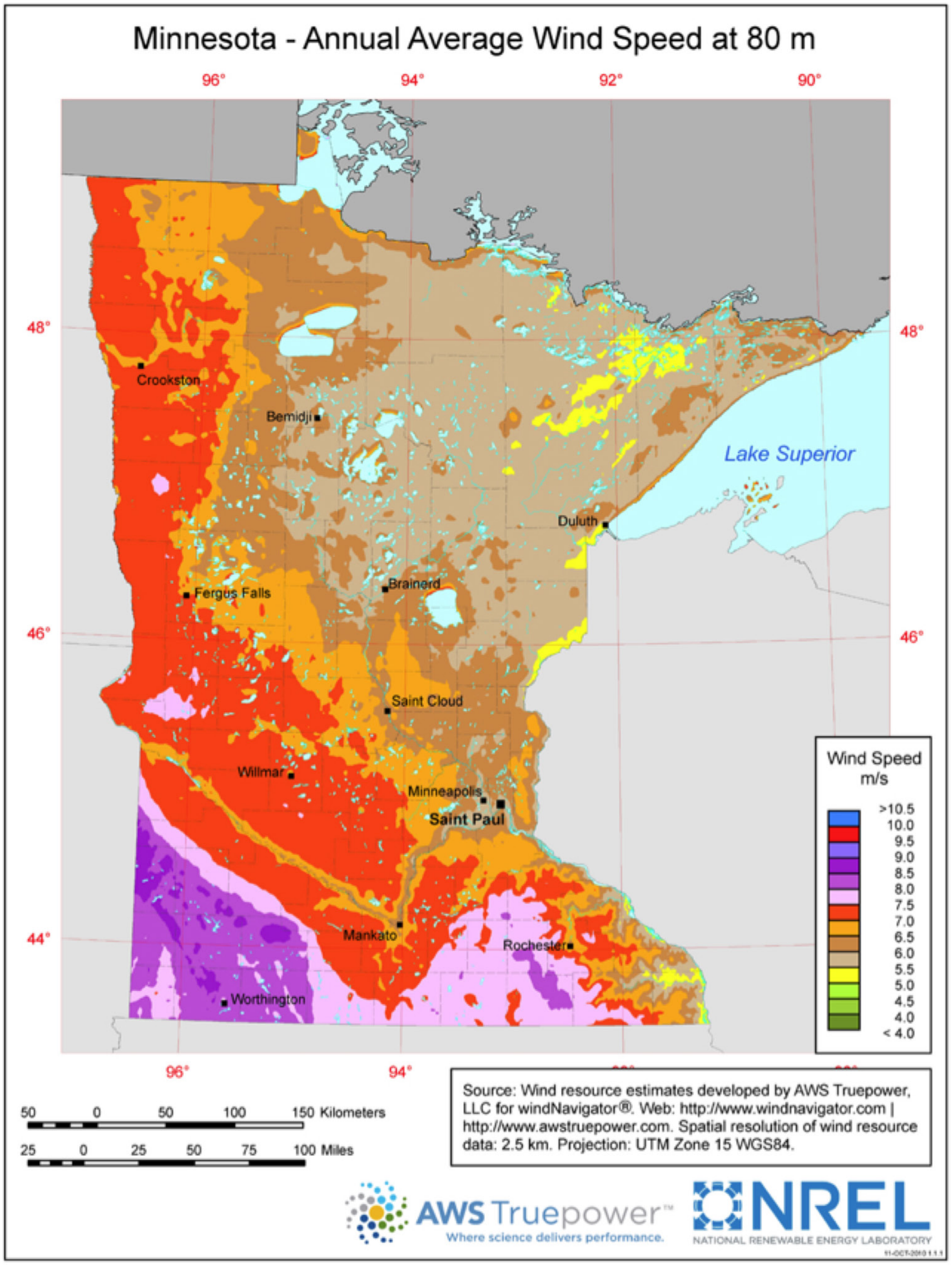
Solar Photovoltaic (PV) Cell: A material that captures photons from sunlight and turns them into electrons for electricity, often made out of silicon. Many cells are usually used to make a single solar PV panel.

Wind Turbine: A device that creates electricity through electromagnetic induction when it spins.

Windmill: A device that uses the wind's energy to do physical work such as grind grains or pump water.

Average wind speed at 80 meters

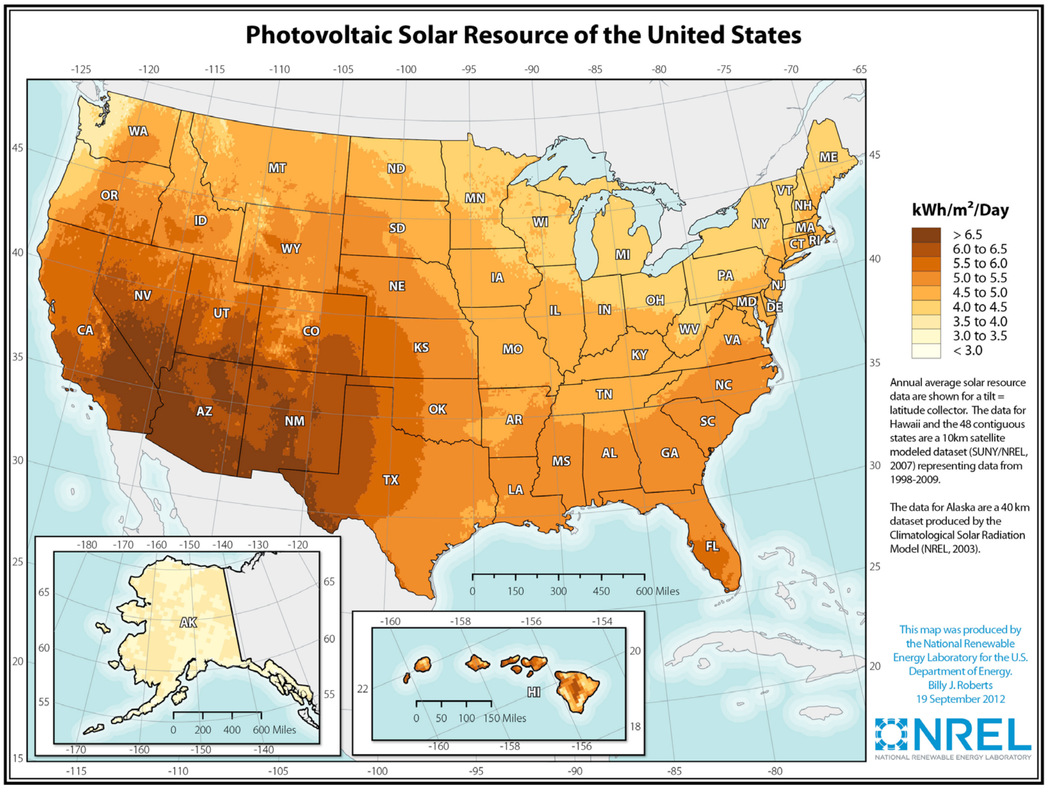
This map pertains to the wind energy potential of the state. The highest wind speeds are seen in the southwest corner of the state, shown in purple. This is also, without coincidence, the area of greatest wind energy development in Minnesota.



Source: US Department of Energy

Photovoltaic Solar Resources of the United States

This map shows the amount of solar energy that hits the surface of the United States each day. Clear regional differences in solar potential are depicted, with darker colors indicating greater solar energy. Minnesota spans at least two colors which tells us that different parts of our own state naturally get more solar energy and thus can be said to be better for solar development.

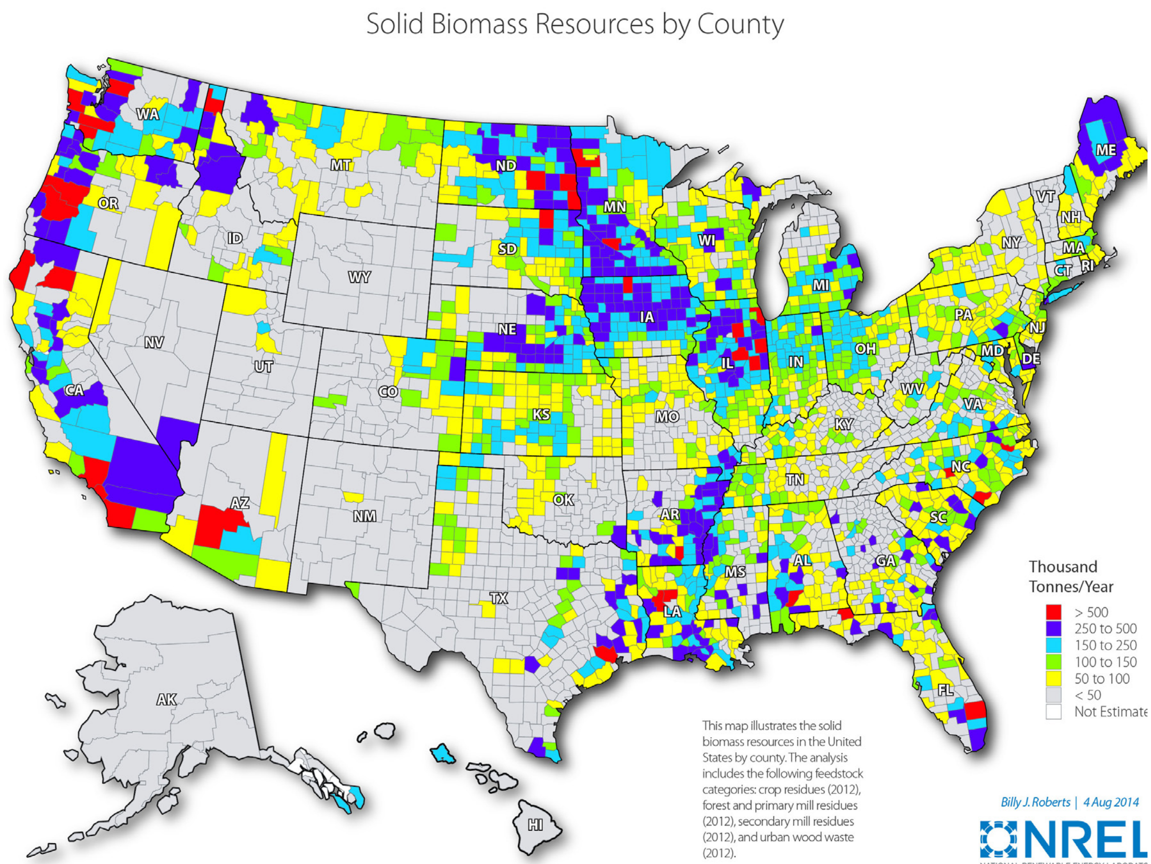


Source: National Renewable Energy Laboratories

CLIMATE GENERATION

Biomass Resources of the United States: Total Resources by County

Minnesota stands out in this map for being just one of a handful of states with a significant biomass capacity. Forest and timber mill byproducts or "residues" account for much of the capacity in the north part of the state. Down in the southwest it's crop residue that is primarily used. This is just one of many interesting biomass maps available from the National Renewable Energy Laboratories (NREL).



Source: National Renewable Energy Laboratories

Lesson 6: What would my dream green school look like?

"We can apply everything we have learned creatively"

Age Level:	Grades 3-8
Time Needed:	Two 45-60-minute periods
Materials:	Art supplies (construction paper, glue or glue sticks, scissors, colored pencils or markers, etc.) Writing utensils Position Statement template Science notebook
Student Learning Outcomes:	Students will apply knowledge gained from previous lessons to the design and creation of a model dream green school Students will know how to write position statements relative to designed projects and social/environmental solutions

Background

This final lesson is built to serve as a way to synthesize all of the content learned throughout this set of energy education lesson plans. It has two parts:

1. Your Dream School: Students will have an arena to design and draw their own ideal school and apply all of the concepts they have learned throughout the past energy lessons, as well as applying the design process. This serves to express their vision for one solution to the problem of climate change and energy use, their judgment based on the pros and cons of energy sources, uses and impacts and, hopefully, to have a little fun.
2. Position Statements: Students will compose brief statements explaining their views about energy use based on what they have learned through this curriculum module.

The first activity gives students the opportunity to apply the process of engineering design. For this activity we consider a simple outline of this process to be:

Define the problem and the resources available
Develop a design
Test the design
Modify the design and test again
Analyze the design and use it or market it
(Minnesota Department of Education)

Notebook Assignment

At the end of this lesson, student notebooks should include preliminary and final designs of their dream school and a position statement.

Energy sources
Efficiency
Conservation
Renewable energy

"My dream as a young child was to create a home where I could live simply, get all of my energy needs from renewable resources and grow the majority of my own food. When I meet young kids, I always tell them to follow their dreams. What dream could be better than being able to thrive, learn and attend a school that models the very best in energy, material and resource efficiency for the health of everyone? It would be designed, constructed and operated to the greatest extent possible within the carrying capacity of the planet. This is a goal worth striving for."

—Will Steger speaking to students, June 2010

Lesson 6: What would my dream green school look like?

"We can apply everything we have learned creatively"

Activity Description:

Activity: Your Dream School (30-45 min.), Grades 3-5 & 6-8

Bring all the lessons together to design and draw the school of your dreams!

Note: As written, this is a 2-D drawing project, however, this project could easily be 3-D. Should you choose to make the Dream School a 3-D project—using cardboard, glue, scissors— it might make a great visual to set next to the wind and/or solar energy projects from lesson 5.

Materials:

Paper
Art supplies (construction paper, glue or glue sticks, scissors, colored pencils or markers, etc.)
Writing utensils

Instructions:

1. Recap the 5 lessons and vocabulary from this curriculum. Use the students' notebooks as a reference by having them go to each lesson in the notes and share important things they remember or learned from that lesson.
2. Explain that using all of the information we have learned about energy, climate change and the environment, students will split into small groups (or work individually) to design their ultimate dream school of the future!
3. This activity is as an opportunity to discuss the process of engineering design. As a group, brainstorm what might be the important steps in designing a school based on what they have learned about energy use, renewable energy and energy efficiency.
    a. Define the problem and the resources available
        i. Prompt the students with questions that relate to defining the problem. For example, what did you learn about energy use in our classroom when we did the audit?
        ii. What did we notice about the school when we walked around it?
        iii. If we were going to make a statement about why we were designing a new school, what might we say?
        iv. A problem statement might be: How do we build a school that meets all our energy needs, but is still efficient?
        v. This activity is an opportunity for students to do some additional research on energy efficient design and renewable energy that they could incorporate.
    b. Develop a design
        i. Give students the opportunity to design their dream school. Make sure they label the important features that show how they are addressing the problem statement.
    c. Test the design
        i. Discuss ways of testing their design. This might include sharing the designs with classmates and getting suggestions. Hang designs around the room and ask students to write feedback on sticky notes.
    d. Modify the design and test again
        i. Based on feedback ask the students to make some modifications of their design.
    e. Analyze the design and use it or market it
        i. Ask students to write up a description for their design that includes some reasons why they think it is important.

4. All groups are encouraged to add flair, color, story and design. Name the building, for added effect.

Lesson 6: What would my dream green school look like?

"We can apply everything we have learned creatively"

Activity: Write Position Statements, Grades 3-5, 6-8

Materials:

Notebook paper
Writing utensils

Students will develop a position statement about energy use based on what they have learned through this curriculum module. Questions they may choose to weigh in on include:

> How can their school be more energy efficient?
> How can their parents or other members of their household save energy?
> Should Minnesota use more or less renewable energy?

Students can use original data collected in their audits, information learned in their lessons and/or do research using some of the resources highlighted in this curriculum. Share student letters with administrators, other family members, the community, local newspapers and decision makers.

Tips for Writing a Position Statement

Keep it short. Limit your letter to one page and one issue.
Identify yourself and the issue. In the first paragraph of your letter state who you are and what issue you are writing about.
Focus on your main points. Choose the three strongest points to support your argument and develop them clearly. Too much information can distract from your position.
Make it personal. Tell your decision maker why the issue matters to you and how it affects you, your family, and your community.
Ask for a reply. Include your name and address on both your letter and envelope. Trust your voice. Be polite and take a firm position in your letter. Be confident in your understanding of the issue and remember that the official may know less than you.

Final Notebook Reflection

Looking back on what they have learned throughout the last 6 lessons, what do they remember most?

Action Project:

Young People's March for Climate Action

Led by the Youth Environmental Activists of Minnesota (YEA! MN), a program of Climate Generation: A Will Steger Legacy

Goal:

Over a hundred young people from across Minnesota gathered on Earth Day to show support for renewable energy and energy efficiency legislation by marching to the Capitol building together. March participants then joined the Minnesota Clean Energy and Jobs Campaign's Earth Day rally.

Why?

Legislation can increase the use of renewable energy and encourage energy efficiency on a large scale. The legislation lobbied for on Earth Day 2013 would increase the state's Renewable Electricity Standard to 40 percent by 2030, and establish a solar standard of 10 percent by 2030 and a series of policies that would advance industrial energy efficiency initiatives. Working for these changes in state policy is a way for individuals to have a broader impact than they could have by changing their own energy usage.

Young people need to be better included in the political process. Even though the voices of young people are very important in decisions that affect the next generation's future, young people are still not heard well enough in the political process. In the 2008 election, only 48 percent of 18 to 24 year olds voted in comparison to 67 percent of those age 30 and up. Encouraging political engagement from a young age—even before voting age—will help make sure young people are better represented.

How?

1. Coordinating with a broader campaign
   - Because political actions are more effective with greater numbers, YEA! MN planned the Young People's March to coincide with the Clean Energy Jobs Campaign's Earth Day Rally. The march arrived at the Capitol building in time to join hundreds of other advocates to support the same legislation.

2. Awareness
   - Posters: YEA! MN put up hundreds of posters in local schools and communities.
   - Social Media: The march was listed as a Facebook event that was frequently advertised on Facebook and Twitter.
   - School Outreach: YEA! MN used contacts at local schools to advertise the March to environmental clubs. They also reached a broader audience by working with the Minnesota Public Interest Research Group to advertise to college students.

3. Planning
   - Route: The route was planned as a fifteen-minute walk to the Capitol.
   - Parade Permit: YEA! MN applied for a parade permit through the police department.
   - March Marshals: Several YEA! MN members were responsible for keeping marchers on the sidewalk during the march.
   - Chant list: YEA! MN handed out copies of a list of chants to use during the march. Chants were pre-planned to focus on the message of the Clean Energy and Jobs Campaign.
   - Buttons: To give march participants a unified look, YEA! MN borrowed a button maker from a local school to make matching buttons.

4. Encouraging Behavior Change
   - Participating in the march let high school and college students participate in the political process when they might not otherwise be involved. For many students, a political action like the Young People's March is a gateway into more involvement.

5. Impact
   - The Clean Energy Jobs Campaign reported that the young people from the March energized the Earth Day Rally and brought the next generation's perspective to the table. On May 23, Governor Dayton signed into law a solar energy standard of 1.5 percent by 2020 for investor-owned utilities and a statewide goal of reaching 10 percent by 2030. Both YEA! MN and the Clean Energy and Jobs campaign will continue working together to pass a stronger renewable energy standard.

Learn more:
www.yeamn.org
www.cleanenergyjobs.mn

Action Project:

South High School
Bike to School Week

Led by South High School's
Green Tigers

Goal:
Organize Bike to School Week to raise awareness of fossil-free transportation options among students at South High School and remind students that they can have a positive impact on their community and environment.

Why?
Fossil free transportation uses less energy. Riding a bike or walking conserves both the energy and money that go into a daily car commute.
Transitioning to a bicycle commute is doable. The US Census Bureau's American Community Survey found that the share of Americans commuting by bike has grown 47 percent since 2000. Statistics like this show that for more and more people, switching to a bicycle commute is a very realistic step toward a less energy-intensive lifestyle.

How?
1. Planning
    - Prizes: The group contacted local restaurants and businesses to ask for donations of gift cards, bike gear, and food. These prizes were raffled off to students who biked to school during the week.
    - Bike Racks: Extra bike racks were rented and installed for the week to accommodate increased bike usage.
    - School Permissions: Group members cleared the project with school administrators and engineers.

2. Advertising
    - The group used posters throughout the school as well as a video on the morning announcements to publicize the week to students.

3. Community Outreach
    - City Officials: The group contacted many city officials to invite them to make an appearance at one of the morning Bike to School Week events.
    - Political Action: A neighborhood political organizer helped the group make petitions for students to sign during the week. Petitions were for improved bike safety and better bike paths in the South High School neighborhood.

4. Running the Week
    - Each morning, members of the Green Tigers club arrived at school early to set up a table with signs, raffle baskets, and petitions and welcome students who had biked to school.

5. Impact

- Green Tigers leader Shira Breen says that after Bike to School Week: “Students are more informed on bike safety issues and more inspired to bike.” Along with encouraging students to bike more frequently, the week also advertises the Green Tigers club and brings in new club members. Since each biker earns a raffle ticket, Green Tigers can measure their success by counting raffle tickets to see how many students biked during the week.

Action Project:

Hydration Station

Led by Central High School's Roots and Shoots

Goal:
Students in the Roots and Shoots at Central High School work together to research, fund, and install a hydration station at their school so that students can conveniently fill reusable water bottles.

Why?

- Refilling water bottles uses less energy. Manufacturing bottles to meet America's demand for bottled water uses more than 17 million barrels of oil annually—enough to fuel 1.3 million cars for a year. And that's not including the oil used for transportation.
- Bottled water is more expensive. "Over half of our student body is on free or reduced lunch and buying plastic water bottles for $1.50 each day is an unnecessary expense for students already on a tight budget," said Roots and Shoots member Bryn Shank. Reusable water bottles are more cost effective and this hydration station will make them easier to use.

How?

1. Research
    - Roots and Shoots member Maddy Frawley says, "We conducted a survey of 658 Central students regarding their plastic water bottle consumption habits and the total number of bottles consumed per week was 233. Applying our data to the larger student body, we calculated that about 700 plastic water bottles are used weekly, which amounts to costing students $1,050 a week. Additionally, recent data suggests that only 13% of plastic water bottles are recycled. This means that 87% of those water bottles each week are sent to landfills, where they'll stay for the many years it takes them to decompose. For Central this means that 609 plastic bottles will be headed to landfills every week."

2. Awareness
    - Poster: The club spread the word about both the Roots and Shoots club and the hydration station project with a poster board presented at freshman registration night.
    - Video: a video on the school's morning news advertised the hydration station fundraising efforts

3. Funding
    - Water bottle sales: The club's water bottle sales at school promoted the club, encouraged the use of reusable bottles, and raised money for the project.
    - Dodgeball tournament: The club hosted a well-advertised school dodgeball tournament with a $15 entrance fee.
    - Online Fundraising: An online fundraising site for the project was publicized through social media
    - Grant Writing: With help from an environmental science teacher, Roots and Shoots leaders applied for grants through DoSomething and the ReThink Recycling program.

4. Installation
    - After being contacted by Roots and Shoots leaders, the school district agreed to install the hydration station as soon as all the funding is in place.

5. Encouraging Behavior Change
    - Roots and Shoots will organize two rounds of classroom presentations that will use the hydration station as an educational opportunity. The first presentations will cover waste reduction and the harm of plastic waste and the second will encourage students to recycle. The presence of the hydration station itself will also make it more convenient for students to use reusable bottles and act as a visual reminder for students to reduce their use of plastic bottles.

6. Measuring Impact
    - Tracking meter: Roots and Shoots will track the success of their hydration station by monitoring the station's meter, which displays the number of plastic bottles saved, every month.
    - Cafeteria bottle usage: The club will also work with the school cafeteria to monitor sales of plastic water bottles in the school cafeteria, which they hope will be reduced after the station is installed.

Action Project:

Grow and Give Community Garden

Led by Hopkins High School's Project Focus

Goal:

Hopkins High School students in Project Focus learn gardening skills and develop a greater appreciation for locally grown foods by growing fresh vegetables to donate to a local food shelf.

Why?

- Locally grown food uses less energy in transportation. A 2001 Iowa State University study found that vegetables produced in the conventional system—transported in semitrailer trucks to large grocery stores across the country—traveled an average of 1,518 miles. Transitioning to more locally grown vegetables that don't travel as far from farm to table cuts down on this unnecessary fuel usage.
- Everyone deserves access to fresh, healthy food choices. Project Focus leader Elayna Shapiro says that the community garden project "is a great way to help our community as well as the environment" because it provides fresh, locally grown fruits and vegetables to people who might not otherwise have access to them.

How?

1. Planning
   - Grow and Give: The project was supported by the Grow and Give program, which encourages people to donate their locally grown garden crops to food shelves.
   - Food Shelf: The Project Focus group located an Intercongregation Communities Association food shelf willing to accept their vegetable donations.
   - Garden Plots: The group located two garden plots to buy in a community garden.
   - Plants: To access plants, the club found a local greenhouse that was willing to donate plants to the project.
   - Tools: Group members pooled members' gardening tools to use for the project.

2. Planting
   - Planting Day: After Project Focus group members turned the soil and mixed in compost, the group organized a Planting Day where volunteers helped group members plant the garden. Group members then fenced in both garden plots to protect the plants.

3. Managing the Garden
   - To maintain the garden through the summer, each group member is assigned a week in the summer during which they will manage the watering, weeding, and harvesting of the garden. Vegetables will be brought to the Intercongregation Communities Association food shelf as they are harvested.

4. Encouraging Behavior Change
   - Project Focus group members and other volunteers brought into the project gain a better sense of the connection between food and their environment—something that is often missing for students in a more urban setting. This encourages participants to think more deeply about the sources of their food and to consider more local options. Bringing the Grow and Give program into the community garden also raises awareness of the program, inspiring others to donate garden crops to the food shelf.

Appendix B: Action Plan

Part One: Brainstorming

1. What issue are you most passionate or interested in as they relate to energy use and efficiency and/or the impacts of climate change in Minnesota? Why?

2. What do you want to see change at your school and/or what does your school or community need to do to be more energy efficient and educated and help mitigate or adapt to the impacts of climate change?

3. What connections do you see between your passions and the needs of your school/community?

4. Use the space below to jot ideas for potential projects based on the previous questions and your participation in workshops/discussions:

Part Two: Action Plan

Now that you've done some brainstorming, it's time to get more specific. Here is a step-by-step process that can help you identify a project and develop SMART goals.
Use the Project Planning Worksheet to create a strategic and successful action project while referring to the steps below to guide your work.

Step One: Choose a Project Focus

Some potential areas to work on are listed below, but don't limit yourself to these ideas! Get creative, and address the greatest needs in your school or community!

Project ideas include: energy efficiency on campus, climate change curriculum/awareness/eco-literacy education, greening your school cafeteria, organic gardening, composting, recycling, reducing your school's carbon footprint, less dependence on fossil fuel transportation, make your school a bike friendly school, build a rain garden, plant trees and native plants, green financing/purchasing, etc.

The area I will focus on for this action plan is: ______________________________

Something to keep in mind when you're creating your Goals and Objectives is S.M.A.R.T. decision-making.
S.M.A.R.T. stands for "Specific, Measurable, Achievable, Realistic, and Timely." You can begin with some pretty lofty goals (such as the desire to make your community 100% carbon neutral), but they have to be broken down into manageable activity chunks that have specific measures of success. For example, rather than have a goal of "Get everyone at school to start recycling," the S.M.A.R.T. way of stating that goal would be to say: "Get 2 recycling bins placed in each classroom and create a student-led pick-up program for this year."

There are two major benefits of having realistic goals with definite measurements of success. One: you'll feel a sense of accomplishment when you've met your goal. The community will also be able to see progress – and will therefore be much more likely to get involved. Two: the people who give you money for your project will prefer those kinds of specific goals. If you need to write a grant or ask the local millionaire's club for a donation, they will ask for specifics to make sure that their money goes toward some tangible achievement.

S.M.A.A.R.T.T.

Specific	can be well-defined and clearly understood by anyone who has basic knowledge of the project
Measurable	can know if a goal is obtainable, when it has been achieved and how far away completion is
Achievable	can be achieved within the current environment
Agreed Upon	agreement with all the stakeholders what the goals should be
Realistic	can be accomplished within the availability of resources, knowledge and time
Timetable	are limited by a timeframe
Tangible	anyone can experience it

Step Three: Building Your Team

As much as you'd love to do this solo, you're going to have to partner with a team, group, and/or organization in order to achieve your goals. You may already have a team you're working with, or you may be starting from scratch- either way, it's helpful to know who you'll be working with. Brainstorm a list of the people that you want to include in your team. This could include students passionate about your issue, students working in related groups, teachers/advisors/administrator, facility management, community members, parents, etc.

Step Four: Identifying Potential Roadblocks
Brainstorm a list of potential obstacles you may need to overcome in order to reach you goal (for example: lack of funding, disinterested students, no administrative support, intimidating facilities manager, etc).

Step Five: Identifying Your Project Resources
What space, money, materials and other resources do you have that will help to achieve your goals?
Consider your assets:
Human assets—individual skills and knowledge of members of your community
Association assets—groups that have come together for a common purpose
Institutions(public or private)—schools, local government, businesses, nonprofits
Built Assets—buildings, public spaces, other infrastructure
Financial Assets—Funding potential, grants, investments, etc.

Step Six: Building Support
Who needs to know about this project? How will you share your story and build the support you need?

Step Seven: Making a Project Timeline
Create a realistic and concrete timeline that includes preparation for your project, project implementation, and any wrap-up or follow through that needs to happen.

Step Eight: Implement Your Project
Get out there and DO something great!

Step Nine: Share Your Success!
Report on your accomplishments to your school and community via newspapers, forums and social media. Drop us an email and let us know what you have been up to, education@climategen.org

Part Three: Climate Action Plan Summary

Use the action plan worksheet to fill out this summary.
Full name of lead educator/adult mentor contact: ____________________
First names of student group members: ____________________

Email: ____________________
Phone number: ____________________
School/grade: ____________________
What is your project focus? ____________________

Please list your top three S.M.A.R.T.T. goals

a) ____________________

b) ____________________

c) ____________________

Include a brief summary of your timeline

____
____
____
____
____
____

ACTION PLAN WORKSHEET

1 Project Focus: ______________________________

Specific
Measurable
Achievable
Realistic
Timetable

2 Goals/Objectives:	3 Your Team:	4 Road Blocks:	5 Resources/Assets:	7 Timeline of Activities (by month):
				Nov:
				Dec:
				Jan:
				Feb:
				Mar:
				Apr:
				May:
				June:
				Next School Year:

6 Building Support:

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