

Environmental Literacy Unit Plan

Grade: 8, Physical Science

Title: *Energy in my Every Day Life*

Authors: Rabiah Harris, Kelly Miller; Kamellia Keo, McKinley Middle; Alex Rose-Henig, Basis; Walker Timme, Langdon

NGSS Unit Plan

Title of Unit	Energy in my Everyday Life!	Grade Level	8
Curricular Theme	<i>Physical Science</i>	Time Frame	9 weeks
Essential Question(s) to be Addressed	How do the choices you make affect the environment?		

Background Information and Context

NGSS Performance Task Expectations: Students who demonstrate understanding can:

- **MS-PS3-1.** Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.
- **MS-PS3-2.** Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.
- **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.

Applicable Common Core Standards (CCSS ELA and CCSS Math)

ELA/Literacy

- **RST.6-8.1.** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions (MS-PS3-1, MS-PS3-5)
- **RST.6-8.3.** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS3-3, MS-PS3-4)
- **RST.6-8.7.** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS3-1)
- **WHST.6-8.1.** Write arguments focused on discipline content. (MS-PS3-5)
- **WHST.6-8.7.** Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS3-3, MS-PS3-4)
- **SL.8.5.** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS3-2)

Mathematics

- **MP.2.** Reason abstractly and quantitatively. (MS-PS3-1, MS-PS3-4, MS-PS3-5)

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- **8.EE.A.1.** Know and apply the properties of integer exponents to generate equivalent numerical expressions. (MS-PS3-1)
- **8.EE.A.2.** Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that $\sqrt{2}$ is irrational. (MS-PS3-1)
- **8.F.A.3.** Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS3-1, MS-PS3-5)

Prior Understandings

- Describe that energy cannot be created or destroyed, *but can change form*.
- Understand that an example of energy *changing form* is a ball bouncing (change from potential to kinetic energy).
- Understand that energy is always conserved (although it may not appear to be conserved).

Community Connections: Sustainability Initiative

The National Building Museum/Green Design Fieldwork Day is the community connection. Consider using this at the beginning of the unit (or near the beginning) to get students thinking about possible solutions for creating their device/tool (*something that helps reduce dependence on fossil fuels*) towards the end of the unit. This fieldwork can take several forms, but here are two suggestions:

1. Teachers obtain a list of GREEN buildings in different Wards of the city that host or could allow tours to learn about the features of the building.

This is described in the EXPLORE phase of the summative assessment part of this draft unit plan. A tour guide or a tour list for the teacher can enable to students to look at specific components of the building that enabled developers/occupants to be more “green” in their design.

Beth Gingold from the Department of General Services is available as a resource to help with finding tour guides and other energy-related resources. (beth.gingold@dc.gov)

Some examples:

- Ward 2: American Society of Landscape Architects, 636 Eye St NW, U.S. Botanic Garden, 100 Maryland Ave SW
 - Ward 5: Casey Trees Headquarters, 3030 12th Street NE
 - Ward 6: OCTO/CFSA Building, 200 I Street SE
 - Ward 7: HD Woodson High School, 540 55th Street NE
2. Visit the National Building Museum to participate in one of the following workshops. (All workshops cost \$100 per workshop)



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- Be A Green Builder (max 30 students and only 1 daily) (<http://www.nbm.org/schools-educators/school-visit/be-a-green-builder.html>) b.
- Green By Design (max 30 students, but 2 can run at the same time and there are 2 time slots daily) (<http://www.nbm.org/schools-educators/school-visit/green-by-design.html>)

Note: The National Building Museum offers fee-based programs. A limited number of free programs are available for Title 1 public schools. The museum is no longer able to offer free programs to any non-Title 1 schools. These free program slots fill quickly, so we suggest registering as early as possible. Registration for school year usually begins in August. If you foresee problems paying for your Museum visit, you may contact the School & Youth Groups team by email at youthgroups@nbm.org to discuss payment options. (Information source is <http://www.nbm.org/schools-educators/school-visit/school-programs-faq.html>)

Ideas for Panelists for feedback and evaluation can include:

- Representatives from the Pepco Speakers Bureau (202-872-2089 or pepcospeakersbureau@pepco.com)
- Landscape Architects
- Engineers
- Green Builders
- Representatives from the Department of General Services (e-mail: beth.gingold@dc.gov)
- U.S. Green Building Council Representatives at (202) 828-7422)

Disciplinary Core Ideas: (Students will know...)

PS3.A: Definitions of Energy

- Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed. (MS-PS3-1)
- A system of objects may also contain stored (potential) energy, depending on their relative positions. (MS-PS3-2)
- Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present. (MS-PS3-3, MS-PS3-4)

PS3.B: Conservation of Energy and Energy Transfer

- When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5)
- The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3-4)
- Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3)

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PS3.C: Relationship Between Energy and Forces

- When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object. (MS-PS3-2)

ETS1.A: Defining and Delimiting an Engineering Problem

- The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (secondary to MS-PS3-3)

ETS1.B: Developing Possible Solutions

- A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (secondary to MS-PS3-3)

Science and Engineering Practices: (Students will...)

Developing and Using Models

- Modeling in 6–8 builds on K–5 and progresses to developing, using and revising models to describe, test, and predict more abstract phenomena and design systems.
- Develop a model to describe unobservable mechanisms. (MS-PS3-2)

Planning and Carrying Out Investigations

- Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.
- Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim. (MS-PS3-4)

Analyzing and Interpreting Data

- Analyzing data in 6–8 builds on K–5 and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis.
- Construct and interpret graphical displays of data to identify linear and nonlinear relationships. (MS-PS3-1)

Constructing Explanations and Designing Solutions

- Constructing explanations and designing solutions in 6–8 builds on K–5 experiences and progresses to include constructing explanations and designing solutions supported by multiple sources of evidence consistent with scientific ideas, principles, and theories.

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- Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process or system. (MS-PS3-3)

Engaging in Argument from Evidence

- Engaging in argument from evidence in 6–8 builds on K–5 experiences and progresses to constructing a convincing argument that supports or refutes claims for either explanations or solutions about the natural and designed worlds.
- Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon. (MS-PS3-5)

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence

- Science knowledge is based upon logical and conceptual connections between evidence and explanations (MS-PS3-4, MS-PS3-5)

Crosscutting Concepts: (Students will connect...)

Scale, Proportion, and Quantity

- Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes. (MS-PS3-1, MS-PS3-4)

Systems and System Models

- Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems. (MS-PS3-2)

Energy and Matter

- Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion). (MS-PS3- 5)
- The transfer of energy can be tracked as energy flows through a designed or natural system. (MS- PS3-3)

Performance Task

Performance Task Description:

As the population increased, the demand for technology, resources *and energy* has also increased. This has expanded the global human ecological footprint. As we improve our knowledge about the interactions between humans and the environment, we are discovering new ways to help mitigate our negative environmental effects. We want students to lead the charge in design and developing these environmental technologies.

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Students will design and construct a device/tool for everyday use that ***helps reduce dependence on fossil fuels for energy***. The device should directly enhance efficiency or reduce energy use, as informed by measurable or observable data.

Students' designs should be centered around one target area (residential, transportation, school, recreation *teachers are welcome to add an additional target area*). Students will present their design to a panel of "investors" (teacher, peers, family, school board, an actual business, etc.) similar to the TV show *Shark Tank*.

Goal	In groups, students will design and construct a device/tool/technology/structure for everyday use that <i>enhances energy efficiency (or reduces energy use)</i> . Students will make a persuasive presentation about their device to a panel of investors in their presentation students should convince the panel to invest in their design by explaining: <ul style="list-style-type: none"> How it works to reduce energy usage. Why investors should invest (the purpose, profitability, and practicality). Cost/benefit analysis (monetary, environmental, social).
Role	Students take the role of: <ul style="list-style-type: none"> An energy auditor: analyze their personal energy consumption or the energy consumption of their target area. A team of engineers: propose a solution/design to increase/maximize energy efficiency in their target area.
Audience	Student groups will present to a variety of audiences for their investor panel. Panel members might include: teacher, peers, family, the general public, business leaders, school administrators, etc.) depending on the scope and target area of their design. <i>*It will be the teacher's responsibility to establish and invite panel members, but it is the student groups' responsibility to indicate their intended audience.*</i>
Situation	Each presentation is a professional and persuasive product pitch in the style of current primetime TV show " <i>Shark Tank</i> ." Each group should represent their "company" in their pitch conducted in front of a live audience including class members, the teacher, and their investor panel.
Product/Performance	Student should have produced: <ul style="list-style-type: none"> Problem they are addressing Before and after energy usage data/ analysis (with the device) Their device Panel presentation Persuasive letter

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Other Evidence	<ul style="list-style-type: none"> Design of the product Rationale for design Comparison <i>analysis (DATA?)</i> Analysis must contain how energy is transferred from one form to another
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Grouping Strategies	Materials and Equipment Required
<p>Survey/Pre-assignment</p> <ul style="list-style-type: none"> Ask students to write a BCR on what two areas of their lives they think have the greatest impact on their personal energy consumption. In groups, students jigsaw the energy data for four areas the class decides are most important and choose one to focus on. Group students based on interest. (Teacher ensures even groups) 	<ul style="list-style-type: none"> Computer or a way to access research data Investigate school's energy use online using the online database from DGS http://dgs.dc.gov/page/dgs-invites-dc-public-schools-sign-2nd-annual-sprint-savings-energy-competition Device materials (dependent on student projects - Do not approve purchases until student designs have been reviewed and approved.) Use recycled products or purchase materials for which the total cost per group is less than \$20

Comments:

- Solar panels or energy supply donations may be possible from the Three Birds Foundation
<http://www.threebirds.org/programs.html>
- Devices MUST contain a piece of technology that is incorporated into the design. Simply changing behaviors and habits is not sufficient.

Learning Plan/Instructional Sequence

Note: A series of lessons (3-10) Explain and Elaborate in this 5E Sequence

Mini-Unit 1: Energy of Motion

5E Stage: Engage

Lesson 1 Title: Roller Coasters! (1/2 class period)

Science/Engineering Practice or Crosscutting Concept:

- MS-PS3-1.** Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.

Common Core Connections:

- SL.8.5.** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS3-2)
- MP.2.** Reason abstractly and quantitatively. (MS-PS3-1)



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Teacher will:

- Tell students that they will need to make observations about a series of pictures he/she is about to share. The pictures will be of different roller coasters. After students take 5 minutes to look at pictures, students will share with a partner.
- Compile student results for reference later.
- Direct students to answer the questions written to the **right**.

Students should do:

- Analyze the pictures and then share out in pairs or triads what they observed.
- Share out with the class.
- Study the pictures to determine:
 1. Which one seems the scariest?
 2. Which one would have the fastest car?
 3. What components are most important to making the roller coaster travel fast?
 4. If you could design a roller coaster, what would you have?

Evidence of learning:

- Students will begin to form explanations about why roller coaster cars would be able to travel fast based on their components.
- Students will have a roller coaster design that includes pictures and explanations related to “fast” travel for roller coaster cars.

5E Stage: Explore

Lesson 2 Title: Car Investigation (1.5 class periods)

Science/Engineering Practice or Crosscutting Concept:

- **MS-PS3-1.** Plan an investigation individually and collaboratively, and in the design identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.
- Construct and interpret graphical displays of data to identify linear and nonlinear relationships.

Common Core Connections:

- **RST.6-8.3.** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
- **MP.2.** Reason abstractly and quantitatively. (MS-PS3-1),(MS-PS3- 4)
- **8.EE.A.1.** Know and apply the properties of integer exponents to generate equivalent numerical expressions. (MS-PS3-1)

Teacher will:

- Give out materials for students to explore. Students will have the option to change: ramp height or the mass of the car (by adding mass).

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- Explain to students they should conduct an investigation to explain how the motion of the car changes while changing the variable that they choose.
- Prompt students to collect quantitative data and graph it to look for relationships.

Students should do:

- Choose which variable they would like to change. Students will identify dependent and independent variables as well as constants.
- Record data and create a graph.
- Analyze the data to see if there was a pattern between the variables that they changed.
- Share out to the class.

Evidence of learning:

- Students will respond in writing and/or verbally to questions about how the interactions in an ecosystem can be described using a food web, referring both to the models made in small groups and with the whole class.
- Students will identify only change one variable.
- Students will record accurate data through an appropriate group created procedure.
- Students will graph the data and identify the correct relationships that are shown on the graph between independent and dependent variables.
- Students will identify when the car travels the fastest and slowest based on their data.

5E Stage: Explore

Lesson 3 Title: Energy of a Roller Coaster (1-2 class periods)

Science/Engineering Practice or Crosscutting Concept:

- **MS-PS3-2.** Develop a model to describe unobservable mechanisms.
- **MS-PS3-1.** Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.
- **MS-PS3-2.** Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems.

Common Core Connections:

- **RST.6-8.3.** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
- **MP.2.** Reason abstractly and quantitatively. (MS-PS3-1),(MS-PS3- 4)

Teacher will:

- Assign a do-now that brings up their understanding of when the car was able to move fastest on the ramp yesterday.
- Introduce the terms potential and kinetic energy. Teacher will ask students to match these two terms with their understandings from the do-now.

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- Facilitate students' investigation of "How does the potential energy change as the car travels down the roller coaster?"
- Orient students to the Explore Learning gizmo: Roller Coaster Physics.
- Assign student groups/pairs to work on the Gizmo on the computer.
- Circulate to ensure that students are finding the relationship between potential and kinetic energy as students are working.

Students should do:

- Complete the do now.
- Listen to the teacher introduce two new terms and match the terms to their do now responses.
- Make predictions about how the potential energy changes.
- Explore the gizmo in pairs.
- Analyze simulation, including graphs to find the relationship between kinetic energy, potential energy and total energy of the system.

Evidence of learning:

- Accurate matching of vocabulary to the do now observation statements.
- Creation of predictions about potential energy changes in a situation.
- Students can accurately articulate that the total energy of the system remains the same, when the potential energy is greatest and when the kinetic energy is greatest.

5E Stage: Elaborate

Lesson 4 Title: Creating a Cooling Device (1 class period)

Science/Engineering Practice or Crosscutting Concept:

- **ETS1.A: Defining and Delimiting an Engineering Problem**
 - The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions.
- **ETS1.B: Developing Possible Solutions**
 - A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem.

Common Core Connections:

- **MP.2.** Reason abstractly and quantitatively. (MS-PS3-1), (MS-PS3-4), (MS-PS3-5)
- **RST.6-8.7.** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS3-1)

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- **RST.6-8.1.** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. (MS-PS3-1), (MS-PS3-5)

Teacher will:

- Propose the question: *How can potential energy be used to keep you cool?*
- Ask students to create a device out of a specific list of materials that can keep you cool by using storing energy.
- Prepare the materials for project: paper, spring, paper clip, straw, rubber band.
- Instruct students to create an idea for design.
- Approve design and allow students to begin constructing.
- Monitor construction, asking probing questions including:
 1. Is your device keeping you cool?
 2. How can you make the air flow faster?
 3. How can you make the air flow for a longer period of time?
 4. How is potential energy used in your model?
 5. How is kinetic energy used in your model?

Students will do:

- Individually write reflection on device that includes the following:
 1. Diagram of device.
 2. Explanation of construction process.
 3. Use of potential and kinetic energy.
 4. Proof that the law of conservation of energy is followed.
- Evaluate another group's device in groups for effectiveness.
- Respond to these questions individually:
 1. How long did the device work for?
 2. Does the device keep you cool?
 3. How is potential and kinetic energy reflected in the length of time it works and how the device keeps you cool?

Evidence of learning:

- According to rubric: students will accurate diagram and explain their device. Students will also clearly identify the potential and kinetic energy and explain how the law of conservation of energy is followed.
- Students will be able to evaluate another group's device for effectiveness by timing another group's device, explaining if it can keep the user cool and relate the first two components back to potential and kinetic energy.

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5E Stage: Evaluate

Lesson 5 Title: Analyzing a Device (1/2 class period)

Science/Engineering Practice or Crosscutting Concept:

- **MS-PS3-1.** Motion energy is properly called kinetic energy; it is proportional to the mass of the moving object and grows with the square of its speed.
- **MS-PS3-2.** A system of objects may also contain stored (potential) energy, depending on their relative positions.
- **MS-PS3-2.** When two objects interact, each one exerts a force on the other that can cause energy to be transferred to or from the object.
- **MS-PS3-1.** Proportional relationships (e.g. speed as the ratio of distance traveled to time taken) among different types of quantities provide information about the magnitude of properties and processes.
- **MS-PS3-2.** Models can be used to represent systems and their interactions – such as inputs, processes, and outputs – and energy and matter flows within systems.

Common Core Connections:

- **MP.2.** Reason abstractly and quantitatively. (MS-PS3-1), (MS-PS3-4), (MS-PS3-5)
- **SL.8.5.** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS3-2)
- **RST.6-8.7.** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS3-1)
- **RST.6-8.1** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. (MS-PS3-1), (MS-PS3-5)

Teacher will:

- Assign students to respond to a reflection about their device:
 1. Diagram of device.
 2. Explanation of construction process.
 3. Use of potential and kinetic energy.
 4. Proof that the law of conservation of energy is followed.
- Facilitate switching of devices to evaluate another group's device on effectiveness.
- Assign students to add a review of another group's device to their reflection for the activity:
 - o How long did the device work for?
 - o Does the device keep you cool?
 - o How is potential and kinetic energy reflected in the length of time it works and how the device keeps you cool?

Students should do:

- Individually write reflection on device that includes the following:
 1. Diagram of device.
 2. Explanation of construction process.
 3. Use of potential and kinetic energy.

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4. Proof that the law of conservation of energy is followed.
- Evaluate another group's device in groups for effectiveness.
- Respond to these questions individually:
 1. How long did the device work for?
 2. Does the device keep you cool?
 3. How is potential and kinetic energy reflected in the length of time it works and how the device keeps you cool?

Evidence of learning:

- According to rubric: students will accurate diagram and explain their device. Students will also clearly identify the potential and kinetic energy and explain how the law of conservation of energy is followed.
- Students will be able to evaluate another group's device for effectiveness by timing another group's device, explaining if it can keep the user cool and relate the first two components back to potential and kinetic energy.

Mini-Unit 2: Energy of Temperature

5E Stage: Engage

Lesson 6 Title: Heating Up or Cooling Down? (1/2 class period)

Science/Engineering Practice or Crosscutting Concept:

- **MS-PS3-4.** Science knowledge is based upon logical and conceptual connections between evidence and explanations.
- **MS-ETS1-3.** Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors.
- **MS-ETS1-3.** Analyze and interpret data to determine similarities and differences in findings.
- **MS-PS3-5.** Energy may take different forms (energy in fields, thermal energy, energy of motion).
- **MS-PS3-3.** The transfer of energy can be tracked as energy flows through a designed or natural system.

Common Core Connections:

- **RST.6-8.3.** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
- **WHST.6-8.1.** Write arguments focused on discipline content.

Teacher will:

- Activate and pass around a hand warmer and ice pack to the students, having students write down ideas and share out prior knowledge what the technology is, what it is used for, what happens and make predictions on how it works.
- [Elicit conversations about the changes in temperature over time.]

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- Split students into small groups and direct students to brainstorm ways in which they cool down in the summer and heat up in the winter.
- Record all ideas, dividing the ideas into two categories: technologies and behaviors
- Have students explain how these ideas perform its task (heating up or cooling down).

Students should do:

- Write down observations about the hand warmer and ice pack: What is it? What does it do? Wow does it work? What happens to it over time?
- Share out observations.
- Brainstorm ways in which they cool down in the summer or heat up in the winter.
- From the list, students will describe behaviors to keep warm (e.g., rubbing their hands, moving around).
- Share out with the whole class.

Evidence of learning:

- Students will make observations and share out with the group, making predictions and inferences about the ice pack and hand warmer.
- Students will create a list and reflect on behaviors and technologies designed to reach the desired temperature, connecting to motion.

5E Stage: Explore

Lesson 7 Title: Who Killed Frosty the Snowman? (1/2-1 class period)

Science/Engineering Practice or Crosscutting Concept:

- **ETS1.A.** The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (secondary to MS-PS3-3)
- **ETS1.B.** A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (secondary to MS-PS3-3)
- **MS-PS3-4.** Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.

Common Core Connections:

- **RST.6-8.3.** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
- **RST.6-8.7.** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
- **WHST.6-8.1** Write arguments focused on discipline content.

Environmental Literacy Unit Plan

Grade: 8, Physical Science

Title: *Energy in my Every Day Life*

Authors: Rabiah Harris, Kelly Miller; Kamellia Keo, McKinley Middle; Alex Rose-Henig, Basis; Walker Timme, Langdon

- **MP.2.** Reason abstractly and quantitatively.
- **8.EE.A.1.** Know and apply the properties of integer exponents to generate equivalent numerical expressions. (MS-PS3-1)
- **8.F.A.3.** Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS3-1),(MS- PS3-5)

Teacher will:

- Put an ice cube (or snow) in a funnel (10 minutes prior to class) and every 2 minutes, the students will collect and record the volume of ice melted.
- Direct students to record the data on a table and plot the point in the front of the room.
- Review how to plot points on a graph.
- Lead class discussion of patterns the students see.
- Challenge students melt one ice cube the quickest and preserve the ice cube in its form the longest.

Students should do:

- Measure the amount of water melted from the ice/ice cube every 2 minutes, plotting and copying the data from the class.
- Consider the question: How can we speed up or slow down the melting of an ice cube?
- Brainstorm ideas and designs with the mystery bag of supplies.
- Use a variety of ways to melt an ice cube.
- Use a variety of ways to preserve an ice cube without a refrigerator.
- Record the amount of time and other observations of both ice cubes.
- Closing: Students will explain observations, results, challenges, propose possible alternatives, and make connections to the real world.

Evidence of learning:

- Students will be able to discuss the process of design, rationale for solution, challenges, and ideas for further research.
- Students will turn in a lab report.

5E Stage: Explain

Lesson 8 Title: Keep It Moving (1 class period)

Science/Engineering Practice or Crosscutting Concept:

- **MS-PS3-4.** Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.

Common Core Connections:

- **RST.6-8.3.** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Environmental Literacy Unit Plan

Grade: 8, Physical Science

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Authors: Rabiah Harris, Kelly Miller; Kamellia Keo, McKinley Middle; Alex Rose-Henig, Basis; Walker Timme, Langdon

- **WHST.6-8.1.** Write arguments focused on discipline content.
- **MP.2.** Reason abstractly and quantitatively.

Teacher will:

- Review: Ask students what happens to a popsicle if you leave it out in the sun all day? What happens when you leave a cup of hot coffee outside in the winter time?
- Ask how those two are related.
- **Hook activity:** Teacher will prepare two 1000mL graduated cylinders. One filled with hot water, one filled with cold water. The teacher will ask students to jot down any observations, inferences and possible explanations of what they see. The teacher will place a few drops of the food coloring (at the same time) into both columns.
- Lead discussion where students share out observations.
- Instruct students individually, in groups or pairs to complete the Gizmos (e-learning, see resource list for website references) assignment on phase changes, complete the ES.
- Set up a lab with hot water and cold water containers, an empty water bottle (half-sized works the best), and soapy water. Teacher will read the directions to the students (ACS. see below “Air, it’s really there”).
- Closing: Lead discussion of students explaining the relationship between temperature, molecular motion, kinetic energy and phase using pictures, words to explain the phenomenon of the bubble inflating or deflating.

Students should do:

- Complete the Review/Do Now independently.
- Share out in whole group.
- **Hook activity:** Students will be writing down observations, inferences and possible explanations in a chart.
- Complete the worksheet aligned for the Gizmos activity on phase changes. Students will complete and achieve mastery on the final ES in the Gizmo.
- Perform the lab according to the directions.
- Write down observations.
- Closing: Students will be asked to explain the relationship between temperature, molecular motion, kinetic energy and phase using pictures, words to explain the phenomenon of the bubble inflating or deflating.

Evidence of learning:

- Students will explain the concepts of heat transfer in the review
- Students will provide possible explanations for the phenomenon
- Students will complete the worksheet and achieve mastery on the 5 questions following the Gizmos activity
- Students will be asked to explain the relationship between temperature, molecular motion, kinetic energy and phase using pictures, words to explain the phenomenon of the bubble inflating or deflating.

Environmental Literacy Unit Plan

Grade: 8, Physical Science

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Authors: Rabiah Harris, Kelly Miller; Kamellia Keo, McKinley Middle; Alex Rose-Henig, Basis; Walker Timme, Langdon

5E Stage: Elaborate

Lesson 9 Title: Temperature Experiment (1 class period)

Science/Engineering Practice or Crosscutting Concept:

- **ETS1.A.** The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (secondary to MS-PS3-3)
- **ETS1.B.** A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (secondary to MS-PS3-3)
- **MS-PS3-4.** Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.

Common Core Connections:

- **RST.6-8.3.** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
- **RST.6-8.7.** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
- **WHST.6-8.1.** Write arguments focused on discipline content.
- **MP.2.** Reason abstractly and quantitatively.
- **8.EE.A.1.** Know and apply the properties of integer exponents to generate equivalent numerical expressions. (MS-PS3-1)
- **8.F.A.3.** Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS3-1),(MS- PS3-5)

Teacher will:

- Review: Introduce the following scenario to your students: You buy balloons at the party store and decide to have them inflated inside of the store. The store manager tells you to not fill it to capacity. It is 102 degrees outside. Explain why you should or should not listen to the store manager.
- Explain the experiment: Students must comparing final water temperatures after different masses of ice melted in the same volume of water with the same initial temperature, the temperature change of samples of different materials with the same mass as they cool or heat in the environment, or the same material with different masses when a specific amount of energy is added.

Students should do:

- Independently complete the review and share out.
- Complete the prelab, perform the lab and complete the worksheets provided by the teacher
- Closing: Students must also diagram and explain the relationship between temperature, molecular motion, kinetic energy and phase using pictures, words to explain their findings



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Evidence of learning:

- Review: Students will write down and explain the review.
- Students will complete the lab and must also diagram and explain the relationship between temperature, molecular motion, kinetic energy and phase using pictures, words to explain their findings.

5E Stage: Evaluate

Lesson 10 Title: Thermal Cup (1-2 class periods)

Science/Engineering Practice or Crosscutting Concept:

- **ETS1.A.** The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. (secondary to MS-PS3-3)
- **ETS1.B.** A solution needs to be tested, and then modified on the basis of the test results in order to improve it. There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. (secondary to MS-PS3-3)
- **MS-PS3-4.** Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.

Common Core Connections:

- **RST.6-8.3.** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
- **RST.6-8.7.** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).
- **8.EE.A.1.** Know and apply the properties of integer exponents to generate equivalent numerical expressions. (MS-PS3-1)
- **8.F.A.3.** Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS3-1),(MS- PS3-5)

Teacher will:

- Prepare lab with cold or hot water containers, and recyclable materials for construction.
- Present challenge to the students: students must design and construct a cup that would insulate the contents the best, maintaining the starting temperature of the water for the longest amount of time.
- Approve design, rationale, and pre-construction questions.
- Move from group to group asking probing questions on rationale, results, and real-world applications.

Environmental Literacy Unit Plan

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Students should do:

- Design and construct a cup that would insulate the contents the best, maintaining the starting temperature of the water for the longest amount of time.
- Decide between hot or cold water and predict which materials would work the best.
- Record the temperature of the water and atmosphere over a period of time.
- Graph and analyze the results to determine the materials used.

Evidence of learning:

- Complete a lab report/write up

Mini-Unit 3: Translations of Energy

5E Stage: Engage

Lesson 11 Title: Dead Battery (1/2 class period)

Science/Engineering Practice or Crosscutting Concept:

- **MS-PS3-5.** Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion).

Common Core Connections:

- **MP.2.** Reason abstractly and quantitatively.

Teacher will:

- Show students a battery and ask what does the battery do? What are some objects that need batteries? (Encourage students to make a list.)
- Demonstrate putting battery into a small battery powered object/device, but it does not turn on. Ask students, why did it not turn on? Where did the energy in the battery go? What kind of energy did the battery have?

Students should do:

- Brainstorm ideas where the energy from the battery went and where it comes from.
- Describe what they use batteries for.

Evidence of learning:

- Students list guesses for what kind of energy a battery provides and what they use batteries for.



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5E Stage: Explore

Lesson 12 Title: Powered Devices (1 class period)

Science/Engineering Practice or Crosscutting Concept:

- **MS-PS3-4.** Science knowledge is based upon logical and conceptual connections between evidence and explanations.
- **MS-PS3-5.** Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion).

Common Core Connections:

- **MP.2.** Reason abstractly and quantitatively.
- **RST.6-8.7.** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Teacher will:

- Ask students what other types of energy they can think of. If students are struggling to get started, may remind them that they already learned about thermal energy
- Provide students a set of materials to create “powered devices.” Teachers should try to have devices that are powered by alternate forms of energy, such as: mechanical energy (hand crank), solar power, thermal energy, etc. (One option for this is the SnapCircuits Alternative Energy Kit – see resources.)
- Circulate to see what students create and prompt them to try powering the same device with an alternate form of energy.

Students should do:

- Brainstorm a list of different types of energy.
- Challenge their groups to create devices powered by multiple sources.
- Create diagrams of every device they power. For example, students can create fans powered by batteries, plug, or other types of energy sources (snap circuits or other similar systems).

Evidence of learning:

- Students have a list of possible different types of energy, and how energy is transferred from one type to another.
- Students will create a powered device and a diagram for how it works.

5E Stage: Explain

Lesson 13 Title: Types of Energy (1-2 class periods)

Science/Engineering Practice or Crosscutting Concept:

- **MS-PS3-4.** Science knowledge is based upon logical and conceptual connections between evidence and explanations.



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- **MS-PS3-5.** Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion).

Common Core Connections:

- **RST.6-8.1.** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.
- **MP.2.** Reason abstractly and quantitatively.
- **RST.6-8.7.** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

Teacher will:

- Prompt students to look at diagrams from the last class period's creations and to begin to think about how energy is converted to make the object work.
- Set up readings and videos for students to identify the correct forms of energy transfer.
Readings/videos should be about:
 - a. hydroelectric power
 - b. thermal
 - c. solar
 - d. wind, etc.
- Facilitate timeline for students to read and share out information within their group. One option for the jigsaw is for students to read articles/watch videos with students not in their group, but reading the same article and then return to their group to "report out."

Students should do:

- Label diagrams with the energy changes that occur and begin to describe the transformations that take place.
- Jigsaw readings/videos within groups and share out with group to label appropriate energy transfer within the diagrams/devices.

Evidence of learning:

- Students will create labeled diagrams of the energy changes.
- Students will be able to describe the energy transfer within each of the diagrams/ devices.

5E Stage: Elaborate

Lesson 14 Title: Alternative Energy Car Creation (1-2 class periods)

Science/Engineering Practice or Crosscutting Concept:

- **MS-PS3-4.** Science knowledge is based upon logical and conceptual connections between evidence and explanations.

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Authors: Rabiah Harris, Kelly Miller; Kamellia Keo, McKinley Middle; Alex Rose-Henig, Basis; Walker Timme, Langdon

- **MS-PS3-5.** Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon.
- **MS-PS3-5.** Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion).

Common Core Connections:

- **WHST.6-8.1.** Write arguments focused on discipline content.
- **MP.2.** Reason abstractly and quantitatively.

Teacher will:

- Ask students how cars are powered and if they know alternate energy powered cars.
- Show the video: “Japan, A Nation of Recyclers and -Energy Misers- “available on NBC LEARN (<http://www.nbclearn.com/portal/site/k-12/browse?cuecard=38989>)
- Ask students to respond to what is occurring in the cars shown.
- Issue the students a challenge to design their own “toy” cars that are powered by alternative energy. Ideas for alternative energy sources include (but are not restricted to): hand crank, blowing fan, battery, and solar power. Students compete against other groups in a car race.
- Approve designs for construction.
- Ask the following probing questions as students are creating:
 - o How can you increase the speed of the car?
 - o What type of energy is used to power the car?
 - o What type of energy is produced from the source energy?
 - o How does the mass of the car affect how fast it travels between different energy types?

Students should do:

- Describe how energy from gas is converted into kinetic energy that moves the car.
- List examples of alternate energy powered cars.
- Respond to questions related to how the cars are powered in the video about Japan.
- Listen to the challenge problem and design a solution.
- Get their designs approved by the teacher. Create their own cars using renewable energy sources and respond to the teacher’s probing questions.
- Write a reflection based on their own car based on:
 - o car design
 - o source energy
 - o energy produced
 - o how the energy is transformed.
- Race their cars.
- Add to their reflection, feedback on other groups’ designs.



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Evidence of Learning:

- Students will produce a reflection on the car they designed, discussing: the rationale for the car design; the source of energy; the energy produced; and how the source of energy is transformed into the energy produced.
- Students will also produce a revised reflection based on peer feedback.

Mini-Unit 4: Going Green! Design Challenge

Disclaimer READ FIRST: This is the final mini performance assessment for all of the following performance expectations. However, it is not intended as an opportunity to re-teach standards related to those performance expectations. In fact, different student projects might not hit every one of the following performance expectations.

5E Stage: Engage

Lesson 15 Title: The Environment and Us (1/2-1 class period)

Science/Engineering Practice or Crosscutting Concept:

- **MS-PS3-4.** Science knowledge is based upon logical and conceptual connections between evidence and explanations.
- **MS-ETS1-3.** Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. Analyze and interpret data to determine similarities and differences in findings.
- **MS-PS3-5.** Energy may take different forms (energy in fields, thermal energy, and energy of motion).
- **MS-PS3-3.** The transfer of energy can be tracked as energy flows through a designed or natural system.

Common Core Connections:

- **MP.2.** Reason abstractly and quantitatively. (MS-PS3-1), (MS-PS3-4), (MS-PS3-5)
- **8.F.A.3.** Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS3-1), (MS-PS3-5)

Teacher will:

- Instruct students to draw, write, and describe ways in which students improve the environment.
- Instruct students to sort their ideas into two categories: energy related vs non-energy.
- Emphasize the unit focus on energy.
- Instruct students to sort their energy column into 2 categories behavior (human action) vs. technology.

Environmental Literacy Unit Plan

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- Move from group to group, posing questions such as the differences between behavior and technologies to improve the environment and its effectiveness, and their findings of their lists.
- Gather all groups together and discuss patterns.

Students should do:

- Independently brainstorm ways in which they improve the environment then share with an elbow partner.
- In pairs, sort their ideas into two categories energy-related, non-energy related.
- Share their ideas and sort the energy group into two categories: behavior related and technology related, discussing their findings

Evidence of Learning:

- Students will be able to identify ways (direct and indirect) they work to improve the environment, discussing behaviors and technologies used by looking at patterns and trends.

5E Stage: Explore

Lesson 16 Title: Getting Energized! (4-5 class periods)

Science/Engineering Practice or Crosscutting Concept:

- **MS-PS3-4.** Science knowledge is based upon logical and conceptual connections between evidence and explanations.
- **MS-ETS1-3.** Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. Analyze and interpret data to determine similarities and differences in findings.
- **MS-ETS1-1.** All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment. The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.

Common Core Connections:

- **6.SP.B.5.** Summarize numerical data sets in relation to their context. (MS-PS3-4)
- **8.F.A.3.** Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS3-1), (MS-PS3-5)
- **MP.2.** Reason abstractly and quantitatively. (MS-PS3-1), (MS-PS3-4), (MS-PS3-5)
- **WHST.6-8.7.** Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS3-3), (MS-PS3-4)

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Teacher will:

- 1A. Provide directions to the students on how to play the guessing game.
- 1B. Facilitate conversation for the rationale of the matching.
- 2A. Define target area and list target areas (student provided) and provide computers for students to conduct energy audit and survey.
- 3. Group students and illicit activity to explore energy use and environmental impact.
- 4A. Take students on a fieldtrip to a green building and illicit conversations about green design and purpose.
- 4B. Instruct students to write a list of possible designs for their device and initiates a gallery walk.
- 4C. Facilitates student voting for the top 5 design ideas.

Students should do:

- 1A. Arrange and match energy source to % consumption (guessing game).
- 1B. Explain rationale for matching cards and propose an explanation.
- 2A. Students will identify target areas and perform energy audit.
- 2B. Students will take online survey and analyze carbon footprint.
- 3. Students will perform a jigsaw activity to explore energy use and environmental impact.
- **Think of a solution:**
 - 4A. fieldwork/green building/green design
 - 4B. Make a big list of possible designs in groups. Write on board and gallery walk.
 - 4C. **Generate Ideas:** Voting activity on different brainstormed design ideas.

Evidence of Learning:

- 1B. Student explanation
- 2A. Identification of target areas
- 2B. Survey of carbon footprint reflection
- 4A. Identification of green building components implemented
- 4B. Brainstormed list of designs

5E Stage: Explain

Lesson 17 Title: Energizing Designs (1-2 class periods)

Science/Engineering Practice or Crosscutting Concept:

- **MS-PS3-3.** Apply scientific ideas or principles to design, construct, and test a design of an object, tool, process, or system.

Common Core Connections:

- **6.SP.B.5.** Summarize numerical data sets in relation to their context. (MS-PS3-4)
- **MP.2.** Reason abstractly and quantitatively. (MS-PS3-1), (MS-PS3-4), (MS-PS3-5)

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- **WHST.6-8.7.** Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS3-3), (MS-PS3-4)

Teacher will:

- Instruct students to write down their top three choices from the gallery walk.
- Create groups from students' choices and ensure that groups are even with some balancing of areas.
- Instruct students to make detailed blueprints of their design.
- Encourage students to be mindful of cost when creating their designs.
- Direct students to use their energy data from the audit to create justification for their device.
- Create a series of questions for students to reflect about that encourages them to reference the energy data as a part of the design:
 1. What does this device/tool do?
 2. How does this device/tool use energy?
 3. How does this device/tool show energy transformations?
 4. How does this device/tool prove the law of conservation of energy?
 5. How will this tool specifically reduce energy use?
 6. If used for a week, what would you expect the change in energy to be (quantitatively)? Why?

Students should do:

- **Compile all documents in one place for reference later.**
- Create "choice sheets" where they choose their top three choices from the gallery walk.
- Form groups that the teacher has chosen from their "choice sheets."
- In their project groups, decide on the device or tool they would like to create, from the list of top voted-on ideas (see explore lesson).
- Begin making a blueprint of their design with ideas.
- Students will create a justification for why this device/tool will help to reduce energy use in the target area. The justification will correspond to the six questions the teacher asks.

Evidence of Learning:

- Students will accurately:
 - o Connect their device to energy use in a target area.
 - o Explain what energy powers their device/tool.
 - o Explain energy transformations that occur in the device.
 - o Explain how the device/tool changes the amount of energy.
 - o Quantitatively make predictions about how energy use will be changed with justification.



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5E Stage: Elaborate

Lesson 17 Title: Green Design Challenge (2-3 class periods)

Science/Engineering Practice or Crosscutting Concept:

- **MS-ETS1-1.** All human activity draws on natural resources and has both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.
- **MS-ETS1-1.** The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.
- **MS-PS3-5.** Energy may take different forms (energy in fields, thermal energy, energy of motion).
- **MS-PS3-3.** The transfer of energy can be tracked as energy flows through a designed or natural system.
- **MS-ETS1-1.** Define a design problem that can be solved through the development of an object, tool, process or system and includes multiple criteria and constraints, including scientific knowledge that may limit possible solutions.

Common Core Connections:

- **MP.2.** Reason abstractly and quantitatively. (MS-PS3-1), (MS-PS3-4), (MS-PS3-5)
- **SL.8.5.** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS3-2)
- **RST.6-8.1.** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. (MS-PS3-1), (MS-PS3-5)
- **WHST.6-8.7.** Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS3-3), (MS-PS3-4)
- **RST.6-8.3.** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS3-3), (MS-PS3-4)

Teacher will:

- Organize and facilitate a “glows and grows” activity, followed by a jigsaw style gallery walk. Teacher should be explicit in requiring students to include glows and grows for both the effectiveness of their designs in reducing daily energy use, as well as glows and grows of the design itself.
- Invite experts in to see student group’s preliminary designs for feedback.
- Provide framework for students to make and document changes to their designs, including feedback from themselves, peers, and the invited experts.
- Direct students to begin making a supply list for materials needed, as well as a list of expected tools necessary to construct the design.
- Explain that materials needed must adhere to the following criteria:
 - o Combined cost of materials must be less than \$10.
 - o Recyclable materials should be used whenever possible.
- Purchase the required supplies for each group.

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- Discuss building safety rules and regulations. Teacher will also design a “check-in” system for constantly evaluating student progress.
- Provide guidelines on and help students organize their portfolio of the various justifications that they have written.
- Provide time for students to draft their product pitch.
- Provide feedback on student product pitches.
- Invite experts in to see student group’s preliminary devices for feedback.
- Provide time, and circulate to groups helping make final touches on device/tool.

Students should do:

- Identify strengths and weaknesses of their own designs.
- Circulate in gallery walk identifying glows and grows for other groups projects.
- Present their designs and justification in small groups to experts of what they are thinking so far.
- Revise design using feedback. Student revisions should specifically address each piece of feedback and describe how and why they changed (or did not) their design. Student explanations should formally address the DCI’s relating to their target area, and how the change will reduce carbon consumption.
- Create a supply and tools list based on the teacher’s criteria sheet.
- In groups, work on constructing their device from their revised designs.
- Construct a “product pitch” using the various information they have written. In the pitch, students should describe both the design and revision process.
- In groups, present their device and justification in small groups to the class and the teacher in *Shark Tank* format.
- Revise pitch based on verbal feedback from peers and teachers.
- Present revised product pitch to expert visitors. Students will record expert feedback on, the quality of their design, and device, as well as the quality of their product pitch.
- Make any final revisions to either their device or their pitch.

Evidence of Learning:

- Student and group glows and grows show relevance and rigor related to the design process.
- Student presentations.
- Written justifications will show how well students understand both the design process as well as the energy (MS-PS3) performance expectation relating to their designs.
- Student draft product pitch will show student understanding of their own design process, as well as an understanding of how their device will help the environment in terms of energy use.

5E Stage: Evaluate

Lesson 18 Title: Energy Innovation Showcase (1-2 class periods)

Science/Engineering Practice or Crosscutting Concept:

Environmental Literacy Unit Plan

Grade: 8, Physical Science

Title: *Energy in my Every Day Life*

Authors: Rabiah Harris, Kelly Miller; Kamellia Keo, McKinley Middle; Alex Rose-Henig, Basis; Walker Timme, Langdon

- **MS-PS3-5.** Construct, use, and present oral and written arguments supported by empirical evidence and scientific reasoning to support or refute an explanation or a model for a phenomenon. Energy may take different forms (e.g. energy in fields, thermal energy, energy of motion).
- **MS-ETS1-2.** Evaluate competing design solutions based on jointly developed and agreed-upon design criteria.
- **MS-PS3-3.** The transfer of energy can be tracked as energy flows through a designed or natural system.
- **MS-ETS1-1.** The uses of technologies and limitations on their use are driven by individual or societal needs, desires, and values; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.

Common Core Connections:

- **MP.2.** Reason abstractly and quantitatively. (MS-PS3-1), (MS-PS3-4), (MS-PS3-5)
- **SL.8.5.** Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS3-2)
- **RST.6-8.1.** Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. (MS-PS3-1), (MS-PS3-5)
- **RST.6-8.7.** Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS3-1)

Teacher will:

- Establish and invite the panel members.
- Participate in the panel and ask students about their device and rationale for creating such a device.
 - o Why do you think that device will decrease energy use?
 - o What evidence do you have that the device will decrease energy use?
- Assess (grade) the accuracy and persuasiveness of the presentation and the paper.

Students should do:

- Demonstrate their knowledge by presenting a professional and persuasive pitch about their device to a panel of investors.
- Explain how the device works to reduce energy, why investors should invest, and discuss a cost/benefit analysis.
- Defend the efficiency of their device by fielding questions from the panel.
- Each group of students will indicate who their intended audience is and who they think would be appropriate to be on the panel.

Evidence of Learning:

- Evidence includes the device, presentation, and paper. See rubrics.

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Performance Task Rubrics

Rubric for Mini-Units 1-3:

This rubric was designed to be a general template for all or most performance tasks, based on lab reports and/or presentations.

	4	3	2	1	0
Problem	Students clearly and fully identify and explain the problem they are addressing, providing specific evidence.	Students identify the problem they are addressing and give a vague explanation. No evidence or examples provided.	Students will vaguely identify the problem they are addressing, with minimal explanation.	Students are unclear in identifying the problem and are not sure which problem they are addressing.	Students do not address or identify the problem.
Solution (Rationale for Design/ Comparison Analysis)	<p>Student proposes multiple possible solutions to the problem, including a rationale or explanation of the need and practicality.</p> <p>Student proposes, in detail, several significant ideas for further research.</p> <p>Student fully reflects on their design and suggests several improvements or modifications.</p>	<p>Student proposes several solutions to the problem, and includes a vague rationale or explanation and may not discuss the need or practicality of the design.</p> <p>Student proposes a few ideas for further research.</p> <p>Student reflects on their design and proposes only one or two improvements or modifications.</p>	<p>Student proposes only a few solutions, with little rationale or explanation. Does not discuss the need or practicality of the design.</p> <p>Student provides little or mostly inaccurate data.</p> <p>Student proposes only one or two ideas for further research.</p> <p>Student reflects on their design but does not propose any improvements or modifications</p>	<p>Student proposes only one solution with little to no rationale or explanation. Student does not discuss the need or practicality of the design.</p> <p>Student does not include data.</p> <p>Student does not propose any ideas for further research.</p> <p>Student minimally reflects on their design.</p>	Student does not discuss a solution, reflect, evaluate the engineering practices, and does not propose ideas for further designs/research
Design and Diagram	<p>Design clearly addresses all of the main problems and shows details.</p> <p>Design is scientifically accurate.</p>	<p>Design addresses most of the main problems and provides some details.</p> <p>Design is mostly scientifically accurate.</p>	<p>Design addresses some of the main problems.</p> <p>Design has some significant scientific inaccuracies.</p>	<p>Design is crude and most main points are not addressed.</p> <p>Design has major flaws in scientific accuracy.</p>	Student does not provide nor references designs or diagrams for their device

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Construction: Device/ Tool Product	The device/tool was well constructed and functional, addressing the problem.	The device/tool construction was satisfactory. The device almost completely functioned independently to address the problem.	The device/tool construction was fair. The device minimally functioned independently. It minimally worked to address and solve the problem.	The device/tool was poorly constructed, did not work, and unrelated to the content, design and problem.	Student does not construct a device or tool product.
Science Content	Student clearly identifies, describes, explains and elaborates on the vocabulary and concepts, providing additional examples	Student identifies, and describes the vocabulary and concepts related to the activity and connection to the unit, but does not provide additional examples.	Student is able to identify, describe and explain the relevance of unit, but is unable to make the connection to the activity (or vice versa).	Student is unable to identify, describe or explain the relevance of the activity to the unit, content or vocabulary.	Student does not reference any science content
Written component / Lab report or (Presentation)	Student delivery was clear and concise all of the time, minimally making errors There were minimal grammatical or spelling errors (The student maintained eye contact all of the time)	Student delivery was clear and concise almost all of the time, occasionally making errors. There were 1-2 grammatical or spelling errors (The student maintained eye contact almost all of the time.)	Student delivery was clear and concise about 50% of the time, making pauses and grasping for words. There were 3 -4 grammatical or spelling errors (The student maintained eye contact about 50% all of the time.)	Student delivery was not clear, making long pauses and content was unrelated and unmeaningful. There were more than 5 grammatical or spelling errors (The student looked away most of the time.)	Student did not turn in a written component (Did not present)

Rubric for Summative Assessment:

Students will design and construct a device/tool for everyday use that helps reduce dependence on fossil fuels. Each device should directly enhance efficiency or reduce energy use, as informed by measurable or observable data.

Student designs should be centered around one target area (residential, transportation, school, recreation...*teachers are welcome to add an additional target area*). Students will present their design to a panel of “investors”(teacher, peers, family, school board, an actual business, etc.) similar to the TV show *Shark Tank*. The presentation will include:

- How it works to reduce energy usage.
- Why investors should invest (the purpose, profitability, and practicality).

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- Cost/benefit analysis (monetary, environmental, social)

Product/Performance:

Student should have produced:

- Before and after energy usage data/ analysis (with the device)
- Their device
- Panel presentation
- Persuasive letter

Standard:

- Design of the product
- Rationale for design
- Comparison analysis
- Analysis must contain how energy is transferred from one form to another

	4	3	2	1	0
Problem	Students clearly and fully identify and explain the problem they are addressing, providing specific evidence.	Students identify the problem they are addressing and give a vague explanation. No evidence or examples provided.	Students will vaguely identify the problem they are addressing, with minimal explanation.	Students are unclear in identifying the problem and are not sure which problem they are addressing.	Students do not address or identify the problem.
Solution (Rationale for Design/ Comparison Analysis)	Student proposes multiple possible solutions to the problem, including a rationale or explanation of the need and practicality. Student proposes ideas for additional research/devices. The student includes examples and evidence from their comparison analysis. Student proposes, in detail, several significant ideas for further research.	Student proposes several solutions to the problem, and includes a vague rationale or explanation and may not discuss the need or practicality of the design. The student does not provide comprehensive comparison data. Student proposes a few ideas for further research. Student reflects on their design and proposes	Student proposes only a few solutions, with little rationale or explanation. Does not discuss the need or practicality of the design. Student provides little or mostly inaccurate comparison data. Student proposes only one or two ideas for further research. Student reflects on their design but	Student proposes only one solution with little to no rationale or explanation. Student does not discuss the need or practicality of the design. Student does not include comparison data. Student does not propose any ideas for further research. Student minimally reflects on their design.	Student does not discuss a solution, reflect, evaluate the engineering practices, and does not propose ideas for further designs/research

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	Student fully reflects on their design and suggests several improvements or modifications.	only one or two improvements or modifications.	does not propose any improvements or modifications		
Design and Diagram	Design clearly addresses all of the main problems and shows details. Design increases energy efficiency. Design is scientifically accurate.	Design addresses most of the main problems and provides some details. Design does not clearly increase energy efficiency. Design is mostly scientifically accurate.	Design addresses some of the main problems. Design does not increase energy efficiency. Design has some significant scientific inaccuracies.	Design is crude and most main points are not addressed. Design does not address energy efficiency. Design has major flaws in scientific accuracy.	Student does not provide nor references designs or diagrams for their device
Construction: Device/Tool Product	The device/tool was well constructed and functional, addressing the problem	The device/tool construction was satisfactory. The device almost completely functioned independently to address the problem.	The device/tool construction was fair. The device minimally functioned independently. It minimally worked to address and solve the problem	The device/tool was poorly constructed, did not work, and unrelated to the content, design and problem	Student does not construct a device or tool product
Science Content	Student clearly identifies, describes, explains and elaborates on the energy transformations within the device, providing additional examples.	Student identifies, and describes the energy transformations within the device.	Student is able to identify energy transformation, but is unable to describe or relate it to the device.	Student is unable to identify, describe or explain the energy transformations on the device, but can only describe how the device works. [no vocabulary]	Student does not reference any science content.
Presentation	Student delivery was clear and concise all of the time, minimally making errors The student maintained eye contact all of the time.	Student delivery was clear and concise almost all of the time, occasionally making errors. The student maintained eye contact almost all	Student delivery was clear and concise about 50% of the time, making pauses and grasping for words. The student maintained eye	Student delivery was not clear, making long pauses and content was unrelated and unmeaningful. The student looked away most of the time.	Did not present

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		of the time.	contact about 50% all of the time.		
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Rubric for Persuasive Letter

	4	3	2	1	0
Tone	Student demonstrates a clear understanding of the audience and uses appropriate vocabulary and arguments. The students anticipates the reader's questions and provides thorough answers appropriate for that audience.	Student demonstrates a general understanding of the audience and uses vocabulary and arguments appropriate for that audience.	Demonstrates some understanding of the audience and uses arguments appropriate for that audience.	It is not clear who the author is writing for.	Paper is not a persuasive letter.
Engineering Practice	Student clearly communicates all of the components of engineering design and processes including problem, solution, rationale, design and diagram, reflection of the effectiveness of their device.	Student clearly communicates all but one of the components of engineering design and processes: problem, solution, rationale, design and diagram, reflection of the effectiveness of their device.	Student clearly communicates 2-3 of the components of engineering design and processes including problem, solution, rationale, design and diagram, reflection of the effectiveness of their device.	Student communicates one of the components of engineering design and processes including problem, solution, rationale, design and diagram, reflection of the effectiveness of their device .	Student did not turn in a persuasive letter.
Science Content	Student clearly identifies, describes, explains and elaborates on the energy transformations within the device, providing additional examples.	Student identifies, and describes the energy transformations within the device.	Student is able to identify energy transformation, but is unable to describe or relate it to the device.	Student is unable to identify, describe or explain the energy transformations on the device, but can only describe how the device works. [no vocabulary]	Student does not reference any science content.

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Mechanics	Letter does not have any grammar, spelling, sentence structure errors.	Letter has 1-2 grammar, spelling and sentence structure errors.	Letter has 3-4 grammar, spelling, and sentence structure errors.	Letter has more than 5 grammar, spelling, and sentence structure errors.	Student did not turn in a persuasive letter.
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Checklist for visitors/panel/students:

4 - Distinguished: Student clearly explains all components using evidence. Student demonstrates mastery.

3 - Satisfactory: Student explains almost all of the components. Student demonstrates proficiency.

2 - Fair: Students explains 50% of the components. Student demonstrates some proficiency.

1 - Developing: Student explains less than 50% of the components. Student demonstrates minimal understanding

0 - No evidence

	4	3	2	1	0
<u>Problem</u> Students clearly and fully identify and explain the problem they are addressing, providing specific evidence.					
<u>Solution</u> (Rationale for Design/Comparison Analysis) Student proposes multiple possible solutions to the problem, including a rationale or explanation of the need and practicality. Student proposes ideas for additional research/devices. The student includes examples and evidence from their comparison analysis. Student proposes, in detail, several significant ideas for further research. Student fully reflects on their design and suggests several improvements or modifications.					
<u>Design and Diagram</u> Design clearly addresses all of the main problems and shows details. Design increases energy efficiency. Design is scientifically accurate.					
<u>Construction: Device/Tool Product</u> The device/tool was well constructed and functional, addressing the problem					
<u>Science Content</u> Student clearly identifies, describes, explains and elaborates on the energy transformations within the device, providing additional examples					

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Presentation

Student delivery was clear and concise all of the time, minimally making errors.

The student maintained eye contact all of the time.

Universal Access

Supporting English Language Learners

Reading, Writing, or Speaking Activity	Supports for <u>Emerging</u> Learners	Supports for <u>Expanding</u> Learners	Supports for <u>Bridging</u> Learners
Activities of the Explore Phase (energy audit, research, etc.)	<p>For jigsaw activity and research activities, students can watch a video or listen to a podcast to gather information.</p> <p>For energy audit, students will first make meaning of the tables??? to determine what information the table is given. Then, have a series of data source specific questions for students to answer requiring that they cite specific information in the data. Teacher will give specific instruction to differentiate between fact and opinion.</p>	<p>For jigsaw and research activities, students will be offered video or podcast to listen to. Also, a series of research questions can be given for students to look for specific information. Provide reference card for key terms for science content.</p> <p>For energy audit, students will be given more general guiding questions to analyze data.</p>	<p>For jigsaw and research activities, students will be provided modified grade level texts. Students will analyze research sources for validity and relevance.</p> <p>For energy audit, students will be given a few questions to begin search and then are asked to create their own questions for further research. Students will later collect their own unguided notes using specific strategies.</p>
Presentation: Presentations are done in groups, so all modifications are specific to a task that is appropriate for	Students can write up/explain data collected during device/tool construction.	Students can be in charge of gathering and writing up the “facts” to be used in the presentation.	Students can explain the design the group created and defend why it was used. Students can also make connections between research and device/tool

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their language "can-do's."			
Persuasive Letter	The assignment will be shortened and modified for these students. Students can also use voice to text application (with sentence starters as a script) and then have the student edit the document against a model. (<i>Dragon Dictation is one example.</i>)	Students will receive highlighted instructions for assignment. Provide students with a blank template for use. Also provide students with a reference table of sentence starters for use.	Provide students with a blank template for use. Also, ask students to provide captions for charts and graphs that include subject and relevance for the data.

Supporting Struggling Learners

Activity	Supports for Students who need <i>Minor</i> Support	Supports for Students who Need <i>Intensive</i> Support
Activities of the Explore phase (energy audit, research, etc.).	Students will receive a list of websites for use, reduce the number of required resources for research and a graphic organizer to put their information together.	<p>Students will receive specific target questions, websites with listening options, and access to instructional videos. Students will also use a graphic organizer to put their thoughts and ideas in order. Students will also receive a checklist for things they need to complete each day.</p> <p>Students will receive a reference card with key vocabulary from unit.</p>
Presentation	<p>Students will be provided with a presentation template.</p> <p>Students will have a printed copy of their presentation or index cards for use while presenting.</p>	<p>Students will use dictation tools (like Dragon Dictation) to get their presentation written out.</p> <p>Students will have a printed copy of their presentation with their own notes to highlight part for their use.</p>

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Persuasive Letter	Students will receive an outline and bank of sentence starters. Students will also receive a checklist of components and content to be included.	Students will receive a shortened assignment. Student will receive a template to fill in with blanks for key data, content and space for specifications of device.
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Supporting Advanced Learners

Activity	Extensions for Advanced Students
Activities of the Explore phase (energy audit, research, etc.)	<ul style="list-style-type: none"> For jigsaw, students will be given on and above grade-level informational text. Students should summarize, make connections to the unit and come up with additional examples not included in the text. For research, students must create a bibliography using APA style citation. For the energy audit, students will come up with their own questions. Students should analyze the validity of the data, including comparisons to other sectors (states, countries)
Presentation	<ul style="list-style-type: none"> Students will show the design and results of more than one prototype. Students will make their own notecards with pertinent information. Students will also create a handout that aligns with their presentation and main persuasive points.
Persuasive Letter	<ul style="list-style-type: none"> Students must include at least 2 graphs, tables, and referencing. Students will write a letter, propose a list of appropriate recipients, and actually send the letter to an approved list of recipients. The letter will include current peer-reviewed (journal article) research on the type of energy investigated and tested.

Connecting to the Core: NGSS Aligned Performance Task

ELA Connections (*Reading, Writing or Speaking Activity*) listed in *Learning and Instructional Sequence*

RST.6-8.1. Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions. (MS-PS3-1), (MS-PS3-5)

- Students will have to research their device/tool to determine how it helps reduce use of fossil fuels compared to the original. Students will use this research to defend their selection of a particular tool/device to improve and how increasing energy efficiency will help the environment.

RST.6-8.3. Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (MS-PS3-3), (MS-PS3-4)

- Students will create their own design and device/tool and use energy measurements to compare it to the original.

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RST.6-8.7. Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS3-1)

- In the presentation students will give drawn device specifications and will present data. Students will explain how this new device/improvement increases the efficiency.

WHST.6-8.7. Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS3-3), (MS-PS3-4)

- Students write a short paper, along with their presentation, on the increased efficiency of their chosen tool/device and students will explain how their design increases efficiency. This is a PBL, and students are asked how are the choices you make affect the environment, and students are asked to design a tool/device. Students choose a device or tool to increase the efficiency and they must research how to improve the efficiency and what changes in design must be made.

SL.8.5. Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-PS3-2)

- Students will give an oral a presentation with visual aids to the class convincing the panel of the practicality/efficiency of their design.

Math Connections *(Listed in Learning and Instructional Sequence)*

MP.2. Reason abstractly and quantitatively. (MS-PS3-1), (MS-PS3-4), (MS-PS3-5)

- Students have to use measurable or observable data to prove their design will increase efficiency or reduce energy use. Students will also have to project what they believe will happen to the energy use/efficiency with the new model or design.

6.SP.B.5. Summarize numerical data sets in relation to their context. (MS-PS3-4)

- Students will have to observe energy use data to compare which areas can be improved and will analyze data to compare the rates for other devices/tools.

8.F.A.3. Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. (MS-PS3-1), (MSPS3-5)

- Students will look at the trends in data over time, and compare the slope of lines between groups.

Resources

- <http://www.kineticcity.com>
- Who killed frosty the snowman? <http://sciencenetlinks.com/student-teacher-sheets/case-melting-ice/>
- Gizmo - Phase changes
<http://www.explorelearning.com/index.cfm?method=cResource.dspView&ResourceID=557>
- American Chemical Society
<http://www.middleschoolchemistry.com/lessonplans/chapter2/lesson1>
- Air, it's really there (expanding and compressing molecules in the gas phase)
<http://www.middleschoolchemistry.com/lessonplans/chapter1/lesson5>



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- SnapCircuits Alternative Energy Kit
<http://www.amazon.com/SnapCircuitsAlternativeEnergyGreen/dp/B00CIXVGVY>
- For building cars:
<http://pbskids.org/designsquad/>
<http://www.sciencebuddies.org/>
- http://www.nasa.gov/sites/default/files/images/183836main_edc_flow_5-12_540.jpg
- <http://www.need.org/files/curriculum/guides/Energy%20Flows.pdf>
(pg 9, resource for amount of energy consumption)

Source for the Science and Engineering Practices

[A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas \(2012\)](http://www.nap.edu/openbook.php?record_id=13165) http://www.nap.edu/openbook.php?record_id=13165

Source for the Disciplinary Content and CrossCutting Concepts:

NGSS Lead States. 2013. *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press.

Web Version: Authors: NGSS Lead States. **Title:** Next Generation Science Standards: For States, By States (insert specific section title(s) being used if not referring to entirety of the NGSS). **Publisher:** Achieve, Inc. on behalf of the twenty-six states and partners that collaborated on the NGSS. **Copyright Date:** 2013. **URL:** www.nextgenscience.org.