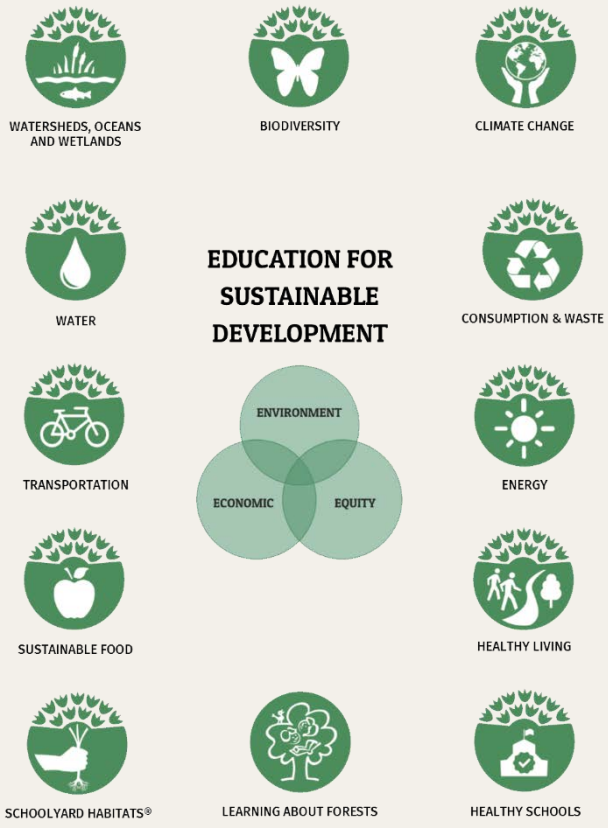
# Pathways to Sustainability

## Alignment to NGSS – HS: Physical Science




Students in high school continue to develop their understanding of the four core ideas in the physical sciences. These ideas include the most fundamental concepts from chemistry and physics but are intended to leave room for expanded study in upper-level high school courses. The high school performance expectations in the physical sciences build on middle school ideas and skills and allow high school students to explain more in-depth phenomena central not only to the physical sciences but to life sciences and Earth and space sciences as well. These performance expectations blend the core ideas with scientific and engineering practices and crosscutting concepts to support students in developing useable knowledge to explain ideas across the science disciplines. In the physical sciences performance expectations at the high school level, there is a focus on several scientific practices. These include developing and using models, planning and conducting investigations, analyzing and interpreting data, using mathematical and computational thinking, and constructing explanations and using these practices to demonstrate understanding of the core ideas. Students are also expected to demonstrate understanding of several engineering practices, including design and evaluation.

The performance expectations associated with the topic **Energy** help students formulate an answer to the question, "How is energy transferred and conserved?" The disciplinary core idea expressed in the NRC Framework for PS3 is broken down into four sub-core ideas: Definitions of Energy, Conservation of Energy and Energy Transfer, the Relationship between Energy and Forces, and Energy in Chemical Process and Everyday Life. Energy is understood as quantitative property of a system that depends on the motion and interactions of matter and radiation within that system, and the total change of energy in any system is always equal to the total energy transferred into or out of the system. Students develop an understanding that energy at both the macroscopic and the atomic scale can be accounted for as either motions of particles or energy associated with the configuration (relative positions) of particles. In some cases, the energy associated with the configuration of particles can be thought of as stored in fields. Students also demonstrate their understanding of engineering principles when they design, build, and refine

devices associated with the conversion of energy. The crosscutting concepts of cause and effect; systems and system models; energy and matter; and the influence of science, engineering, and technology on society and the natural world are further developed in the performance expectations associated with PS3. In these performance expectations, students are expected to demonstrate proficiency in developing and using models, planning and carry out investigations, using computational thinking, and designing solutions and to use these practices to demonstrate understanding of the core ideas.

The National Wildlife Federation's Eco-Schools USA programs has aligned two of the five middle school life science topics that meet our learning objectives and outcomes, **Matter and Energy in Organisms and Ecosystems** and **Interdependent Relationships in Ecosystems**.

Our program icons are used to denote pathway connections to the NGSS Performance Expectations and alignment to the Common Core State Standards, CCSS, English Language Arts, ELA and Mathematics.

**Green STEM is an initiative of NWF's Eco-Schools USA program** and is focused on identifying best practice in the STEM fields as it relates to environment-based learning. These elements include:

- Project, problem and place-based learning
- Utilizing the school, both inside and outside, as a learning laboratory
- Interdisciplinary approach
- Innovation space
- A commitment to stewardship
- An inclusive culture, where all students can learn, participate and take action

## ENERGY

**Students who demonstrate understanding can:**

**HS-PS3-2.** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).

**HS-PS3-3.** Design, build and refine a device that works within a given constraint to convert one form of energy into another form of energy.

CLIMATE CHANGE ENERGY

Each Performance Expectation is more successfully accomplished by students who have spent significant time outdoors in the natural world. Using the schoolyard as a learning laboratory, provides students with countless experiential opportunities using inquiry based methods during field investigations. Students will be able to develop and use models with greater precision and understanding and have the ability to communicate understanding with fact-based evidence.

Students who have played an integral role in addressing sustainable development, the environment, economics and equity have the conceptual understanding needed to build new learning around these performance expectation's overarching concept, energy and matter.

Driving Questions – Examples

- How can we, as electrical engineers and materials scientists, design a heating and cooling system for the vulnerable members of our community that are safe and rely only on renewable energy?
- How can we, as mechanical engineers and with support from nutritional specialists and chefs, design a cooking system for those in developing countries that is safe for families to operate and runs on renewable energy?

## ENERGY - CONTINUED

### SCIENCE AND ENGINEERING PRACTICES

- Developing and Using Models
- Constructing Explanations and Designing Solutions

### DISCIPLINARY CORE IDEAS

**PS3.A** Definitions of Energy

**PS3.D** Energy in Chemical Processes

**ETS1.A** Defining and Delimiting Engineering Problems

### CROSSCUTTING CONCEPTS

- Energy and Matter

### CONNECTIONS TO ENGINEERING, TECHNOLOGY AND APPLICATIONS OF SCIENCE

- Influence of Science, Engineering and Technology on Society and the Natural World

Connections to other DCIs to this grade band: **HS.PS1.A** (HS-PS3-2); **HS.PS1.B** (HS-PS3-2); **HS.PS2.B** (HS-PS3-2); **HS.ESS2.A** (HS -P S3-2); **HS.ESS3.A** (HS -P S3-3)

Articulation of DCIs across grade-bands: **MS.PS1.A** (HS-PS3-2); **MS.PS2.B** (HS-PS3-2); **MS.PS3.A** (HS-PS3-2) (HS-PS3-3); **MS.PS3.B** (HS-PS3-3); **MS.PS3.C** (HS -PS 3-2); **MS.ESS2.A** (HS-P S 3-3)

**Common Core State Standards Connections**

ELA/Literacy

**SL.11-12.5** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS3-2)

Mathematics

**MP.2** Reason abstractly and quantitatively. (HS-PS3-2) (HS-PS3-3)

**MP.4** Modelwith mathematics. (HS-PS3-2) (HS-PS3-3)

**HSN-Q.A .1** Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data display s. (HS-PS3-3)

**HSN-Q.A.2** Define appropriate quantities for the purpose of descriptive modeling. (HS-PS3-3)

**HSN-Q.A.3** Choose a lev el of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS3-3)