



# Infinite Potential: Restructuring the Energy Portfolio

**Explore the way energy transfers and transforms, the technologies designed to meet the needs of an energy-hungry planet, and the environmental and economic tradeoffs inherent in our quest towards sustainability with STEM Professionals:**

Janet Green - National Weather Service Space Weather Prediction Center; space weather physicist

Vasily Titov - NOAA Center for Tsunami Research; Director and Tsunami Modeler using MOST and DART

Larry Shadle - National Energy Technology Laboratory; Director of Thermal Science Division

Martin Keller - BioEnergy Science Center, Oak Ridge National Laboratory

Constance Adams - Space Architect, National Geographic Emerging Explorer

- **Mission 1: Critical Current - Defining Energy**
- **Mission 2: Waves of Change - Calculating Transfers and Transformations**
- **Mission 3: Power to the People - The Current State of the Grid**
- **Mission 4: Energy Independence - The Quest for Sustainable Resources**
- **Mission 5: Energy Security - Powering Our Future**

## Cross-Curricular Connections

### Reading & Writing for Technical Subjects:

LST.1: Read and comprehend science and technical texts independently and proficiently and write effectively for a variety of discipline-specific tasks, purposes, and audiences

LST.2: Extract and construct meaning from science and technical texts using a variety of comprehension skills

LST.2.2: Determine the central ideas or conclusions of a text; provide an accurate, objective summary of the text.

LST.2.3: Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

LST.3.1: Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to texts and topics.

LST.4.1: Translate quantitative or technical information expressed in words in a text into visual form (e.g., a table or chart) and translate information expressed visually or mathematically (e.g., in an equation) into words.

LST.7.1: Conduct short research assignments and tasks to answer a question (including a self-generated question), or test a hypothesis, drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

**Literature Selections:** *Rocket Boys, The Killing Sea, Egg Drop Blues, Call Me Kate, The Carbon Diaries 2015, Phoenix Rising, The Gadget, The Science of Supervillains, Hitchhiker's Guide to the Galaxy, Enchantress From the Stars*

**Math:** Algebraic Problem Solving, Using Ratios, Creating and Analyzing Graphs (Bar, Pie, Best-Fit Line), Math in Sports - energy transfer in baseball (The Coefficient of Restitution - COR), Economics (Supply and Demand), Unit Conversions

**Social Studies:** Mythology - Auroras; Sun Worship - Ancient Cultures; Appalachian Culture; Immigration

**Art:** Perpetual Motion Machines; Infrared Photography; Green Architecture

**Music:** Instruments & waves

## Grades 4-5 Science Content & Engineering Standards

**4.PS.2** Investigate the relationship of the speed of an object to the energy of that object. (Mission 2)

**4.PS.4** Describe and investigate the different ways in which energy can be generated and/or converted from one form of energy to another form of energy. (Missions 1, 2, 5)

- 4.PS.5** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. (Missions 1, 2)
- 4.ESS.2** Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. (Missions 4, 5)
- 5.ESS.3** Investigate ways individual communities within the United States protect the Earth's resources and environment. (Mission 4, 5)
- 3-5.E.2** Construct and compare multiple plausible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem. (Missions 1, 2, 3, 4, 5)

## Grades 6-8 Science Content & Engineering Standards

- 6.PS.2** Describe the motion of an object graphically showing the relationship between time and position. (Mission 2)
- 6.PS.3** Describe how potential and kinetic energy can be transferred from one form to another. (Missions 1,2)
- 6.PS.4** Investigate the properties of light, sound, and other energy waves and how they are reflected, absorbed, and transmitted through materials and space. (Missions 1,2)
- 7.PS.5** Investigate Newton's second law of motion to show the relationship among force, mass and acceleration. (Mission 2)
- 7.PS.8** Investigate a process in which energy is transferred from one form to another and provide evidence that the total amount of energy does not change during the transfer when the system is closed. (Law of conservation of energy. (Missions 1,2)
- 7.ESS.7** Describe the positive and negative environmental impacts of obtaining and utilizing various renewable and nonrenewable energy resources in Indiana. Determine which energy resources are the most beneficial and efficient. (Missions 4,5)
- 8.ESS.3** Research how human consumption of finite natural resources (i.e. coal, oil, natural gas, and clean water) and human activities have had an impact on the environment (i.e. causes of air, water, soil, light, and noise pollution). (Mission 4)
- 6-8.E.1** Identify the criteria and constraints of a design to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. (Missions 1,2,3,4,5)
- 6-8.E.2** Evaluate competing design solutions using a systematic process to identify how well they meet the criteria and constraints of the problem. (Missions 1,2,3,4,5)
- 6-8.E.3** Analyze data from investigations to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. (Missions 1,2,3,4,5)
- 6-8.E.4** Develop a prototype to generate data for repeated investigations and modify a proposed object, tool, or process such that an optimal design can be achieved. (Missions 1,2,3,4,5)

## Grades 9-12 Science Content Standards

### HS Environmental Science (Env.)

- Env.2.1** Describe how matter cycles through sources and sinks and how energy is transferred. Explain how matter and energy move between and within components of an environmental system. (Mission 1)
- Env.2.2** Identify the different forms of energy and understand that energy may be converted from one form to another, but cannot be created or destroyed. (Missions 1,2)
- Env.2.4** Recognize and describe the different sources of energy, including fossil fuels, nuclear, and alternative sources of energy provided by water, wind, geothermal, biomass/biofuels, and the sun. (Missions 3,4,5)
- Env.2.5** Give examples of the various forms and uses of fossil fuels and nuclear energy in our society. (Missions 4,5)
- Env.2.6** Understand and describe how layers of energy-rich organic material have been gradually turned into great coal beds and oil pools by the pressure of the overlying earth. Recognize that by burning these fossil fuels, people are passing stored energy back into the environment as heat and releasing large amounts of matter such as carbon dioxide and other air pollutants. (Mission 4)
- Env.2.7** Differentiate between renewable and nonrenewable resources, and compare and contrast the pros and cons of using nonrenewable resources. (Missions 4,5)
- Env.2.8** Cite examples of how all fuels, renewable and nonrenewable, have advantages and disadvantages that society must question when considering the trade-offs among them, such as how energy use contributes to the rising standard of living in the industrially developing nations. However, explain that this energy use also leads to more rapid depletion of Earth's energy resources and to environmental risks associated with the use of fossil and nuclear fuels. (Mission 5)
- Env.2.9** Describe how decisions to slow the depletion of energy sources through efficient technologies can be made at many levels, from personal to national, and these technologies always involve trade-offs of economic costs and social values. (Mission 5)
- Env.2.10** Understand and describe how nuclear reactions release energy without the combustion products of burning fuels, but that the radioactivity of fuels and by-products poses other risks which may last for thousands of years. (Mission 4)
- Env.4.2** Understand that environmental policies/decisions have negative and positive impacts on people, societies, and the environment. (Missions 4,5)
- ES. 3.4:** Evaluate the use of sustainable versus nonrenewable resources. Explain the consequences of overuse and continued increased consumption of limited resources. Analyze and evaluate the benefits of researching, designing, and developing sustainable resources for private use and industry. (Missions 4,5)