Energy Literacy: A Grade 4 Energy Unit Based on the NGSS* and Incorporating Environmental Education

National Science Teachers Association
2014 National Conference
Friday, April 4, 2014
9:30 – 10:30 AM

Presenters: Patty O’Donnell
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Amherst, Massachusetts
## Workshop Agenda:

- Who we are
- Background on development of our Energy Literacy unit
- NEEEA/U.S. EPA Sub-grant
- NGSS alignment
- Design of Unit
- Demonstration of Materials
- Hands-on Renewable Energy investigations
- How to access curriculum unit
Education for a Healthy Planet

About Us
The Hitchcock Center for the Environment is an independent nonprofit organization whose mission is to foster a greater awareness and understanding of our environment and to develop environmentally literate citizens.

Energy Is Electrifying! Curriculum is available for FREE download from the Hitchcock Center website: (see resources dropdown menu)

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Hitchcock Center Grant: *Integrating Environmental Literacy and the Next Generation Science Standards* *

- Funded by the New England Environmental Education Alliance (NEEEA) and the U.S. EPA Environmental Education Sub-Grants program.

- **Why we did this** – we were inspired by the environmental themes elucidated in the National Research Council (NRC) document – *A Framework for K–12 Science Education: Practices, Crosscutting Concepts, and Core Ideas* – which guided the development of the NGSS.

- Provided an opportunity to demonstrate how environmental education can be used as an organizing principal to teach science concepts.

- We developed three environmental focused curriculum units for grades 3-5, aligned with the NGSS:
  - 3rd Grade - *The Pond Ecosystem*
  - 4th Grade - *Energy Is Electrifying!*
  - 5th Grade – *The Hydrosphere, Water and How We Use It*

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History of Hitchcock Centers
Energy Literacy Programs

• We have had an ongoing commitment to Energy Literacy Education

• We provide Professional Development for Teachers of Grades 4, 5 & 6

• We model the curriculum in classrooms

• The NEEEA grant enable us to expand on this curriculum, incorporate the Next Generation Science Standards*, and make it available to a broader audience
Next Generation Science Standards*

- Based on the *Framework for K–12 Science Education*, released by the National Research Council (NRC) of the National Academy of Sciences, in July 2011

- Developed by (NRC), National Science Teachers Association, American Association for the Advancement of Science, and *Achieve*, a bipartisan, non-profit, education reform organization; with writers from 26 lead states

- NGSS released for adoption in April 2013

- Currently adopted by 11 states: California, Delaware, the District of Columbia, Illinois, Kansas, Kentucky, Maryland, Nevada, Rhode Island, Vermont, and Washington.

- Web address:  [http://www.nextgenscience.org](http://www.nextgenscience.org)
Massachusetts and the NGSS

- The MA Draft Revised Science and Technology/Engineering (STE) Standards, released December 2013, are based on the NGSS but are an adaptation of NGSS.

- Expected to move forward for adoption in the 2015-2016 school year

- For more information, refer to the Massachusetts Department of Elementary and Secondary Education website: www.doe.mass.edu/STEM/review.html
Overview of NGSS Format

• The Standards, by Grade Level and Discipline

• Performance Expectations – What is Assessed

• Foundation Boxes:
  - Science and Engineering Practices – How we teach, for example designing investigations and using models
  - Disciplinary Core Ideas – What we teach; the content
    - Physical Sciences (PS)
    - Life Sciences (LS)
    - Earth and Space Sciences (ESS)
    - Engineering, Technology and Applications of Science (ETS)
  - Cross-cutting Concepts – The Interdisciplinary Nature of Science, for example Patterns, Systems, Energy Flows and Cycles

• Connections to Common Core State Standards
NGSS* LAYOUT
Grade Level and Title

Performance Expectations

Science and Engineering Practices
Disciplinary Core Ideas
Crosscutting Concepts

Connections to
- Other science disciplines at this grade level
- Other DCIs for older and younger students
- Common Core State Standards in Mathematics and Language Arts
Decoding the NGSS*

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**Example:**

**Physical Science (PS) Standard - ENERGY – Grade 4**

4.Energy

Students who demonstrate understanding can:

4-PS3-1. Use evidence to construct an explanation relating the speed of an object to the energy of that object. (Assessment Boundary: Assessment does not include quantitative measures of speed in the speed of an object or on any precise or quantitative definition of energy.)

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents. (Assessment Boundary: Assessment does not include quantitative measurements of energy.)

4-PS3-3. Ask questions and predict outcomes about the changes in energy that occur when objects collide. (Clarification Statement: Energy is the change in the energy due to the change in speed, as objects interact.) (Assessment Boundary: Assessment does not include quantitative measurements of energy.)

4-PS3-4. Apply scientific ideas to design, test, and refine a device that converts energy from one form to another. (Clarification Statement: Examples of devices could include electric circuits that convert electrical energy into motion energy of a vehicle, light, or sound, and a passive solar heater that converts light into heat. Examples of constraints could include the materials, cost, or time to design the device.) (Assessment Boundary: Devices should be limited to those that convert motion energy to light or both; the conversion to electricity is not included.)

4-ESS3-1. Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment. (Clarification Statement: Examples of renewable energy resources could include wind energy, water behind dams, and sunlight; non-renewable energy resources are fossil fuels and fossil materials. Examples of environmental effects could include loss of habitat due to dams, loss of habitat due to surface mining, and air pollution from burning of fossil fuels.)

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**Science and Engineering Practices**

**Asking Questions and Defining Problems**

Asking questions and defining problems in grades 3–5 builds on grades K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Make observations to produce data as the basis for evidence for an explanation of a phenomenon or a design solution. (4-PS3-1)

**Planning and Carrying Out Investigations**

Planning and carrying out investigations to answer questions or test solutions to problems in 3–5 builds on K–2 experiences and progresses to include investigations that control variables and provide evidence to support explanations or design solutions.

- Make observations to produce data as the basis for evidence for an explanation of a phenomenon or a design solution. (4-PS3-1)

**Analyzing and Interpreting Data**

Obtaining, evaluating, and communicating information in 3–5 builds on K–2 experiences and progresses to evaluate the validity of a solution to a problem. Data from multiple sources may be compared to draw conclusions.

- Obtain and combine information from books and other reliable media to explain phenomena. (4-ES3-3)

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**Disciplinary Core Ideas**

**PS3.A: Definitions of Energy**

- The faster a given object is moving, the more energy it possesses. (4-PS3-1)
- Energy can be moved from place to place by moving objects or through sound, light, or electric currents. (4-PS3-2)

**PS3.B: Conservation of Energy and Energy Transfer**

- Energy is present whenever there are moving objects, sound, light, or heat. (4-PS3-3)
- Light energy is transferred from place to place. (4-PS3-4)

**PS3.C: Relationship Between Energy and Forces**

- When objects collide, the contact force transfers energy so as to change the objects’ motions. (4-PS3-5)

**PS3.D: Energy in Chemical Processes and Everyday Life**

- When combustible materials burn, the chemical energy of the materials is transformed into energy that can be transferred. (4-PS3-6)

**Crosscutting Concepts**

**Cause and Effect**

- Cause and effect relationships are mutually identified and used to explain changes. (4-ESS3-1)

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**Connections to Nature of Science**

**Science is a Human Endeavor**

- Most scientists and engineers work in teams. (4-PS4-4)
- Science affects everyday life. (4-PS4-5)

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Connection to other DOKs in fourth grade:


Connection core state standards conventions:

- DOK – Depth of Knowledge
- RL.1.1 Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text. (4-PS3-1)
- RL.1.2 Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text. (4-PS3-1)
- RL.1.3 Integrate information from two or more texts on the same topic in order to write or speak about the subject knowledgeably. (4-PS3-1)
- RL.1.4 Use informative/explanatory texts to examine a topic or convey ideas and information clearly. (4-PS3-1)
- RL.1.5 Conduct short research projects that build knowledge through investigation of different aspects of a topic. (4-PS3-2)(4-PS3-3)(4-PS3-4)(4-PS3-5)(4-PS3-6)
- RL.1.6 Recall relevant information from experiences or gather relevant information from print and digital sources; take notes and categorize information, and provide a list of sources. (4-PS3-3)(4-PS3-4)(4-PS3-5)(4-PS3-6)
- W.4.9 Draw evidence from literary or informational texts to support analysis, reflection, and research. (4-PS3-1), (4-PS3-2)

- Mathematics –
- RP.2 Reason abstractly and quantitatively. (4-ESS3-1)
- RP.3 Model with mathematics. (4-ESS3-2)
- RP.4.1A.A.3 Interpret a multiplication equation as a comparison, e.g., interpret 35 = 5 × 7 as a statement that 35 is 5 times as many as 7 and 7 times as many as 5. Represent verbal statements of multiplicative comparisons as multiplication equations. (4-ESS3-1)

4-1A.4A.3 Solve multistep word problems posed with whole numbers and having whole-number answers using the four operations, including problems in which remainders must be interpreted. Represent these problems using equations with a letter standing for the unknown quantity. Assess the reasonableness of answers using mental computation and estimation strategies including rounding. (4-PS3-1)

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*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.*

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# Energy Is Electrifying! Unit Format

- **NGSS* Alignment** is indicated at the beginning of the unit, and referenced in each Daily Plan.

- **Conceptual Flow for Student Understanding** –
  - Background on Energy, Electricity and Electro-magnets
  - Forms of Energy
  - Fossil Fuel Energy Sources
  - Electrical Generation
  - Renewable Energy Sources

- **Focus on Design Investigations** (Correlate with NGSS ETS standards, Grade3-5)
  - Model Electro-magnet generators
  - Renewable Energy Investigations - Wind and Solar

- **Additional Hands-On Activities in Unit:**
  - Light Bulb Comparisons
  - Appliance Efficiency Comparisons

- **Student Energy Chain Drawings** – Illustrate their conceptual understanding of Energy Flow from the Sun, to the lights in the classroom
Unit Resources

- Book *My Light*, by Molly Bang
- National Energy Education Development Project (NEED) [http://www.need.org](http://www.need.org)
- SWITCH ENERGY PROJECT [http://www.switchenergyproject.com](http://www.switchenergyproject.com)

...Plus many more cited in the unit
We reference *My Light* by Molly Bang often in this unit, and include it in our Professional Development bag of materials for teachers. We are inspired by the author’s ability to make a seemingly overwhelming and complex energy concepts accessible. Ms. Bang brilliantly creates connections, and interconnections, all beginning with the singular source of energy for life on earth – our SUN.
Energy Systems Thinking

- Goals: What we want
- Feedback: How to do it better
- Inputs: What we have
- Processes: What has to be done
- Outputs: Things we don’t want
- Things we want: What we want
STEAM-POWERED ELECTRIC GENERATOR
Materials Demonstrated at NSTA Workshop

- Materials in Professional Development Teacher Kit
- Devices for measuring Electric Output
  - Multimeter
  - Kill-A-Watt Meter
- Demo – Hand-made Electromagnet generator
- Hands-On Stations:
  - Wind Energy
  - Solar Energy
# Student Data Sheet for Renewable Energy Stations

## Using Renewable Energy Worksheet

<table>
<thead>
<tr>
<th>Names of People in Your Group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

### Solar Power:

1. How many volts does the solar panel generate? _________

2. What can you do to make it generate half that number?  
   __________________________________________________________

3. Will the solar panel make the LED bulb light?  **yes or no**

4. Can you use the solar energy to light 2 LED bulbs? (Use 2 solar panels connected together.)  **yes or no**

### Wind Power:

1. How many volts does the wind turbine generate? _________

2. What can you do to make it generate half that number?  
   __________________________________________________________

3. Will the wind turbine make the LED bulb light?  **yes or no**

4. Can you use wind energy to light 2 LED bulbs?  **yes or no**
Energy Chain Student Drawings
Sun → Green plant → 300,000,000 years later → Coal → People digging coal → Air pollution → Power plant → Electric wires