



Presented in partnership with The Franklin Institute and National Energy Education Development (NEED) Project

Program Guide

2010-2011





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A message from Denis O'Brien, President and CEO PECO...

Congratulations on being selected to participate in PECO's environmental education program for middle schools. All of us at PECO and our partners, including The Franklin and the National Energy Education Development Project, are thrilled to be part of this important effort.

At PECO, being a good corporate citizen means working with our customers and the communities we serve to help protect and preserve the environment. That is what this project is all about.

Through innovative projects like installing a green roof on our headquarters in Philadelphia...opening our first "totally green" service building in West Chester... working to redesign our Crown Lights message system with new, energy efficient technology...using more bio-fueled vehicles...supporting community open space projects across the region... and helping our customers use less energy and save more money, we are working hard to be a responsible environmental steward.

I thank you for your participation in this program, and for the opportunity to work with your teachers and students to explore new ways to use energy wisely and efficiently.

For Questions or Assistance

About the logistics and grants – Sharon Kiefer of The Franklin Institute - 215-448-1083 - sharonk@fi.edu

About the Field Trips – Sharon Kiefer – 215-448-1083 - sharonk@fi.edu

About the Curriculum and Kits – Mary Spruill of NEED mspruill@need.org or 800-875-5029 or Hallie Mills of NEED at 800-875-5029 or hmills@need.org

About the Educational Energy Audits – Todd Rogers of NEED at trogers@need.org

About any follow-up questions from Training - Todd Rogers of NEED at trogers@need.org or Doug Keaton of NEED at Dkeaton@need.org.

Table of Contents

The Partners	4
The Planning Committee	5
Workshop Agenda	6
Curriculum Committee Approach	8
What Resources are Provided?	9
Field Trips	10
Field Trip Planning and Reflection	11
2010 - 2011 Program Timeline	14
Recommended Program Planning Guide	15
Recommended Pacing	16
Science Notebooks	22

Student Pages

Field Trip Review – Student Reflections	24
Comparing Energy Sources	25
Energy Outreach Project Assignment	26
Energy Outreach Brainstorm and Planning	27

Assessment Pages

Energy Outreach Rubric	29
Program Evaluation – Teacher	30
Program Evaluation – Student	32



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The Partners



www.peco-energy.com

Based in Philadelphia, PECO is Pennsylvania's largest electric and natural gas utility, serving 1.6 million electric and 480,000 natural gas customers in six southeastern Pennsylvania counties

Founded in 1881, PECO is one of the Greater Philadelphia Region's most active corporate citizens, providing leadership, volunteer and financial support to numerous arts and culture, education, environmental, economic development and community programs and organizations to improve the quality of life in the region.

PECO employs more than 2,500 people and is recognized as one of the best places to work in the Philadelphia region. It also has been recognized as Pennsylvania's safest utility, and one of the best in the nation for employee safety performance by the Energy Association of Pennsylvania, the American Gas Association and the Pennsylvania Department of Labor and Industry.

In 2007, PECO invested more than \$350 million in capital spending in its local infrastructure to ensure a higher level of operational excellence for its customers. The company operates and maintains a network with 21,000 miles of distribution and transmission lines and 11,600 miles of underground gas pipelines.



www.fi.edu

The Franklin Institute and The Center for Innovation in Science Learning

Since 1824, The Franklin Institute in Philadelphia, PA has become a stalwart in the informal science industry, as well as, a premier cultural institution for the nation. With its explicit mission "*to inspire a passion for learning about science and technology*" The Franklin Institute has successfully married science education *for all* with a keen appreciation for community engagement and civic responsibility. In its entirety, The Franklin Institute comprises: The Science Center – which includes the science museum, exhibits and programs; The Franklin Center – responsible for the lauded Awards program, *The Journal of The Franklin Institute*, the library, and the curatorial and collections department; and The Center for Innovation in Science Learning – which houses much of the educational and grant based programs. In 2008, in recognition for almost two centuries of excellence, distinguished service and community commitment, The Franklin Institute was awarded the prestigious Institute of Museum and Library Services (IMLS) National Medal for 2008.

The Center for Innovation in Science Learning has exemplified the benefits of collaborative partnerships between Science Centers, corporations and public education systems, and is proud of its association with this PECO initiative. Through its dynamic programs and areas of practice, the Center for Innovation has left its footprint both regionally and nationally on K-12 science education, and has also significantly impacted family and community science awareness. These programs include: Gender and Families in Science; Professional Development; Educational Technologies; Youth Programs; and the magnet public high school – Science Leadership Academy. As the Center for Innovation continues to develop its signature programs, its newfound collaborations with public school districts, as well as private corporations such as PECO, redefine the boundaries and scope of impact for informal science learning environments.



www.need.org

National Energy Education Development (NEED) Project

The mission of The National Energy Education Development (NEED) Project is to promote an energy conscious and educated society by creating effective networks of students, educators, business, government and community leaders to design and deliver objective, multi-sided energy education programs. The NEED Project is dedicated to developing innovative energy education materials and training programs for teachers and students. Launched by Congressional Resolution in 1980, the NEED Program is now a dynamic force in more than 65,000 classrooms nationwide.

The NEED Project's multi-sided training and instructional programs on all aspects of energy, including production, consumption, and economic and environmental issues, give students an understanding of the interrelationship between energy and the environment. More important, NEED's student-directed activities empower students to take active roles in educating their peers, families, and communities about energy issues. NEED programs focus on developing a clear understanding of the science of energy, and then building knowledge of the sources of energy, uses of energy, and the conservation and efficiency of energy.

PECO Energizing Education Program Team

PECO

Denis P. O'Brien, President and CEO, PECO
Jeff Gordon, Manager of Corporate Relations
Christina Kerrigan, Sponsorship Manager
Mellanie Lassiter, Contributions Manager

The Franklin Institute

Dennis M. Wint, Ph.D., President and CEO
Frederic Bertley, Ph.D., Vice President, Center for Innovation in Science Learning
Kim Fraites-Dow, Director of Institutional Giving and Corporate Relations
Sharon Kiefer, Center for Innovation in Science Learning
Susan Holmes, Center for Innovation in Science Learning

National Energy Education Development (NEED) Project

Mary E. Spruill, Executive Director
Hallie Mills, Curriculum Director

Other committee members:

Laurie Bachman, Executive Director, Riverbend Environmental Education Center
Matthew VanKouwenberg, Engineering/Science/Math teacher, Science Leadership Academy
Jean Wallace, Academic Director/CEO, Green Woods Charter School



Presented in partnership with The Franklin Institute and
National Energy Education Development (NEED) Project

**Teacher Training Workshop
Franklin Institute
December 10-11, 2010**

December 10	The Science of Energy, Energy Sources and Electricity Generation
8:00 a.m.	Registration Pick up curriculum materials; take pre-workshop knowledge assessment and network during breakfast.
8:30 a.m.	Welcome from PECO – Jeff Gordon, Manager, Corporate Relations Introductions <i>Meet Sharon Kiefer – PECO Program Administrator – The Franklin Institute</i> <i>Meet the Facilitators – Todd Rogers and Doug Keaton – The NEED Project</i> Overview of the PECO Energizing Education Program Program Activities, Logistics, and Timelines Play Energy Bingo!
9:30 a.m.	Science of Energy Investigate the forms of energy and force, motion, heat, light and energy transformations using the Science of Energy kit.
11:30 a.m.	Electric Connections and Science of Electricity Build a Science of Electricity Model using materials from the NEED Hydropower Kit. Investigate how electricity is generated using the Science of Electricity Model and Station 6 from the NEED Science of Energy Kit.
12:15 p.m.	Lunch – Evaluating Success of the Program
1:15 p.m.	Energy Enigma Understanding the nation’s leading energy sources and how we use them is important. This activity explores facts and data about the energy sources we use each day.
2:15 p.m.	Wind Energy 101 and Investigating Wind Energy Investigate wind energy and its uses with the Energy from Wind kit.
3:30 p.m.	Unit Planning Meet in groups to review the curriculum materials and kits you’ll be receiving and discuss implementation plans
4:00 p.m.	Evaluation, Wrap-Up Activities

December 11 Energy Sources and Energy Efficiency and Conservation

8:30 a.m. Breakfast

9:00 a.m. Solar Energy 101 and Investigating Solar Energy
Investigate solar energy using the Exploring Solar Energy kits.

10:30 a.m. Break

10:45 a.m. Hydropower 101 and Exploring Hydroelectricity
Investigate hydropower and its application to generate electricity using the Exploring Hydroelectricity kit.

12:00 p.m. Lunch – Understanding the Community Project

1:00 p.m. Energy Efficiency and Conservation at Home and School
Activities help build an understanding of energy efficiency at home and school and the science of buildings.

2:15 p.m. The Carbon Cycle Simulation – Understanding Climate Change

3:00 p.m. Unit Planning and Educational Audit Scheduling
Meet in groups to review the curriculum materials and kits you'll be receiving and discuss implementation plans.

Also plan for scheduling your Educational Energy Audit for year three schools.

3:30 p.m. What's Next? The Timeline, The Activities, and Evaluation

4:00 p.m. Adjourn

Valuable online resources for the program:

The PECO Energizing Education Program site and resources: <http://www.need.org/peco>

The NEED website – curriculum, other resources, etc: <http://www.need.org>

The Franklin Institute's site – filled with great stuff: <http://www.fi.edu>

PECO's website: <http://www.peco.com/>

PECO's SmartIdeas Program: <http://www.pecosmartideas.com/>

The Curriculum Committee Approach

“Systems” thinking focuses on how systems’ components interact with the components of other systems. Learning about systems is not another subject added to the curriculum; it is instead a tool used to model and understand relationships in the real world and in the curriculum. The systems-thinking process helps students understand the complex interactions between NATURAL and SOCIAL systems, and develops strategies that facilitate the solving of complex problems.

What is a System?

The scientific idea of a system implies detailed attention to inputs and outputs and interactions among the system’s components.

In this unit, students apply higher-level thinking and creative problem-solving when they explore the interface between the natural and social systems that comprise their own communities. They will develop a more comprehensive understanding of the complexity of real-world concerns as they investigate how diverse cultural, economic, and political systems interact with their natural surroundings. In addition, students can apply their knowledge and skills from across the curriculum to study the systems that define their chosen community.

Systems to consider when introducing energy concepts to students:

Natural Systems: Wetlands; Water; Plants; Ecosystems; Soil; Agriculture; Forest; River

Social Systems: Family; School; Community; Governments: Local, Regional, State, and Federal; as influenced by economics, transportation, cultures, religions and a bigger world-view.

What’s the PECO Program?

The PECO program is “project-based,” combining a four-week classroom component with a school energy audit by students, a field trip (PECO covers costs for both), a community project (for which PECO will provide a grant of \$10K) and an exciting opportunity for students to present their energy projects at a community event at the Franklin Institute.

We are asking our school partners for the following commitments:

- Designate a science faculty member(s) to supervise implementation of the program. Selected faculty will participate in a two-day training session designed and implemented by NEED’s highly qualified training staff.
- Incorporate PECO’s energy-focused curriculum and related activities into your 7th or 8th grade science program during a five week period between February 8 and May 15.
- Students execute both school and home energy audits.
- Work with a community organization (township or municipal governmental agency, environmental organization) on a project that addresses family/local/community energy efficiency by April 30, 2011).
- Submit a final report on the program by May 30, including a summary of the experience, teacher and student evaluations of the curriculum and its related components, as well as a budget indicating how the grant was utilized.
- Assist PECO with efforts to promote the program through print and electronic media coverage.

What Resources are Provided?

PECO is providing schools with:

- Teacher Training
- Curriculum and hands-on kits to teach about:
 - energy transformations
 - solar energy
 - wind generation
 - hydropower
 - energy efficiency
- PECO Field Trips
- Educational Energy Audits
- Grants and Teacher and Student Support for Program Implementation and Project Planning

Teacher Training

Schools will send teams of educators to the PECO Energy Education Workshop, December 10-11, at the Franklin Institute. Materials will be distributed and professional development provided to introduce the program. Breakfast, lunch, parking, and substitute reimbursement will be provided. Teachers will receive a stipend for attending the Saturday session. All participants will receive Act 48 credit as well.

The Curriculum and Hands-on Kits

NEED materials being provided at the Intermediate (6-8) level. NEED encourages teachers to review the materials before using them with their students.

Teacher Guides

We have chosen from over 120 teacher and student guides for teaching the science of energy, sources of energy, electricity and transportation, and efficiency and conservation. All educators participating in the PECO Program will receive a class-set of NEED's Energy Infobooks at grade level. These student readers serve as the text for a comprehensive energy education program.

Hands-on Student Kits

The program will include NEED's hands-on classroom kits including: The Science of Energy, Exploring Solar, Energy From the Wind, Energy From Moving Water, Monitoring and Mentoring School Energy Management Kit, as well as Home Energy Efficiency Kits for students to share with their families.

The PECO Guide to Teaching About Energy

The PECO Program was designed with a Systems Thinking approach to energy and environmental education. The program encourages students to learn about energy through direct engagement – discovering and applying energy knowledge to the energy choices and challenges we all face, both now and in the future. This Guide to Teaching About Energy was created to provide the background and foundation components for the successful completion of the program. The resources referenced in the guide will be provided to participating educators, but are also available online at NEED.org.

Educational Energy Audits

Teams of students and teachers from the schools will work with NEED's certified energy manager Todd Rogers on an Educational Energy Audit of their school building. Todd will work with students for a half-day to provide them an authentic learning experience about building performance and school energy efficiency while taking measurements and collecting data about their building energy use. To schedule your audit, contact Todd Rogers at trogers@need.org.

Field Trips

Exelon Generation and PECO offer opportunities for field trips to our facilities to learn about various types of energy. **Each participating school may one of the sites below (as available) as part of the program.** Contact Sharon Kiefer at The Franklin Institute at sharonk@fi.edu.

Hydroelectric: Exelon Generation owns and operates two hydroelectric generating facilities on the Susquehanna River. The facilities include the [Conowingo Hydroelectric Generating Station](#), located in Darlington, Maryland, and the [Muddy Run Pumped Storage Facility](#), located in Drumore, Pennsylvania.

- [Conowingo](#) “run of the river” hydro plant is operated by Susquehanna Electric Company, a subsidiary of Exelon. Located on the Susquehanna River in northern Maryland, Conowingo has been providing electric power to the regional system since 1928. At the time of construction between 1926 and 1928, the Conowingo hydro station was the single largest generating station ever built in one step and used the latest technology, and the largest turbines and generators ever produced. Conowingo is a great location to visit during shad season in the spring, when students can see shad ladders that help the fish reach their spawning grounds.
- [Muddy Run](#) pumped storage generating station is used to generate electricity for peak demand, usually during the morning and early evening hours. At night as electricity demand decreases, the units are reversed and used as pumps to fill the upper reservoir for subsequent peak demand periods. The 14-mile stretch of the Susquehanna River, known as the Conowingo pond, serves as the lower reservoir for the Muddy Run facility.

Nuclear: Exelon Nuclear is committed to being the best operator of nuclear plants worldwide.

- [Limerick Generating Station:](#) Limerick Generating Station, located in Limerick Township, Montgomery County, PA, is a two-unit nuclear generation facility capable of producing enough electricity for over 1 million homes. The plant site is punctuated by two natural-draft hyperbolic cooling towers, each 507 feet tall, which help cool the plant. Limerick's two boiling water reactors, designed by General Electric, are each capable of producing 1,143 net megawatts. Unit 1 began commercial operation in February 1986, with Unit 2 going on-line in January 1990.

Renewables: Exelon continues to grow its renewable portfolio.

- [Fairless Hills:](#) a two-unit, 60-megawatt (MW) station located inside the USX Fairless Works Facility in Fairless Hills, PA. Fairless Hills uses landfill gas from Waste Management's Tullytown and Grows landfills as its primary fuel source. Exelon purchased the Fairless Hills Generating Station from USX Corporation in 1997. The Fairless Hills TGA and TGB units were recently upgraded and are among the largest landfill gas generation plants in the United States. In 1997, PECO received the Pennsylvania Governor's award for Environmental Excellence for the development of the methane gas generation facility at Fairless Hills.

Fossil Fuels: The Exelon Generation fossil portfolio consists of approximately 6,500 megawatts of capacity produced using coal, oil, and natural gas. The diverse fuel mix allows the company to remain competitive in the deregulated utility market by ensuring power during intermediate shoulder seasons and peak demand times when prices for energy are high. Exelon's peak generation facilities provide more than 2,000 megawatts of supplementary power for use during periods of high demand.

- [Eddystone](#) is a four unit generation facility located on the Delaware River in Eddystone, PA. One of the first super high pressure and temperature plants, Eddystone was at one time the world's most efficient

generating station. It was also a pioneer with “scrubbing” emission control technology. Unit 1 was the first commercial system to use magnesium oxide, achieving 99 percent efficiency.

- Cromby is a two unit generating station located on the Schuylkill River in Phoenixville, PA. The first generator on the Cromby site was a 1904, 350-kw turbine, Rasor’s Meadow Electric Plant, replaced in 1918 with a “modern” 10,000-kw building and then retired in 1929. The current unit houses Cromby Unit 1, which is a leader in its use of emissions and control systems. Cromby Station Unit 1 celebrated its 50th anniversary of efficient power production in 2004.
- Schuylkill is a one-unit, 166 megawatt peak generation facility located on the banks of the Schuylkill River in Philadelphia, PA. The facility operates during periods of increased demand on the regional power grid. Upon completion in 1903, Schuylkill’s original generating units were the largest obtainable at the time, a 2,000-kw unit and a “monster” 5,000-kw unit. They powered the lighting of Market Street, east of City Hall, during a New Year’s celebration in 1909.

Field Trip Planning and Reflection

Conowingo Hydroelectric Plant

Pre-Field Trip Preparation – 2 Days:

1. Students should understand the fundamentals of electricity. In the **Intermediate Energy Infobook** students should read about *Electricity*, pages 32-38 and *Measuring Electricity*, pages 39-41.
2. If you have not conducted the Hydropower module with your students, give them a brief introduction. Students should read *A Hydropower Plant* in the **Energy of Moving Water Student Guide** on pages 15-16 and *Types of Hydropower* on page 18.
3. Break the students into small groups. Using the directions under Day 8 of the **Teacher Guide** (page 9) lead students through the Force of Water Explorations. Student pages can be found on pages 50-54 in the **Student Guide**.

Post-Field Trip Reflection:

Have students reflect on these questions in their science notebooks, and then discuss as a class.

1. What are your initial impressions from your visit to Conowingo? Did your opinion of hydropower change after your visit, why or why not?
2. Describe how the power plant transforms the energy in moving water into electricity.
3. Who uses the electricity generated by the Conowingo Plant?
4. What effect does the dam have on the local environment, wildlife and human populations?
5. How does generating electricity with hydropower compare to other sources for generating electricity that you have learned about?
6. What questions do you have after visiting this power plant?

Muddy Run Pumped Storage Generating Station

Pre-Field Trip Preparation – 2 Days:

1. Students should understand the fundamentals of electricity. In the **Intermediate Energy Infobook** students should read about *Electricity*, pages 32-38 and *Measuring Electricity*, pages 39-41.
2. If you have not conducted the Hydropower module with your students, give them a brief introduction. Students should read *A Hydropower Plant* in the **Energy of Moving Water Student Guide** on pages 15-16 and *Types of Hydropower* on page 18.
3. Break the students into small groups. Using the directions under Day 8 of the **Teacher Guide** (page 9) lead students through the Force of Water Explorations. Student pages can be found on pages 50-54 in the **Student Guide**.

Post-Field Trip Reflection:

Have students reflect on these questions in their science notebooks, and then discuss as a class.

1. What are your initial impressions from your visit to Muddy Run? Did your opinion of hydropower change after your visit, why or why not?
2. Describe how a pumped storage generating station works. How is this different from a traditional hydroelectric power plant?
3. When is electricity generated at Muddy Run, why at these particular times?
4. What effect do the dam and dikes have on the local environment, wildlife and human populations?
5. How does generating electricity with hydropower compare to other sources for generating electricity that you have learned about?
6. What questions do you have after visiting this power plant?

Limerick Generating Station

Pre-Field Trip Preparation – 2-3 days

1. Follow the directions on page 9 of the **Nuclear Energy Teacher Guide** for the *Nuclear Energy Expo*. Students will be assigned topics to read about in the **Energy From Uranium Student Guide** and **Extended Reading Selections**. Working as a group, students will present the information to their classmates through presentations.

Post-Field Trip Reflection

Have students reflect on these questions in their science notebooks, and then discuss as a class.

1. What are your initial impressions from your visit to Limerick Generating Station? Did your opinion of nuclear energy change after your visit, why or why not?
2. Explain how electricity is generated from nuclear energy.
3. What safety measures are employed at the power plant?
4. What impact does Limerick Generating Station have on the local community?
5. How does generating electricity from nuclear energy compare to other sources for generating electricity that you have learned about?
6. What questions do you have after visiting this power plant?

Fairless Hills

Pre-Field Trip Preparation – 2-3 days

1. Use the Museum of Solid Waste and Energy Guide for students to build background knowledge about solid waste, recycling, and waste-to-energy. Students will work in small groups, read background information on a topic and present information to their classmates. Read through the activity carefully and choose which steps you will choose to use with your students.

Post-Field Trip Reflection

Have students reflect on these questions in their science notebooks, and then discuss as a class.

1. What are your initial impressions from your visit to Fairless Hills?
2. Explain how gas is generated from landfills.
3. Explain how the gas is used to generate electricity?
4. Who uses the electricity generated at Fairless Hills?

5. How does generating electricity from landfill gas compare to other sources for generating electricity that you have learned about?
6. What questions do you have after visiting this power plant?

Fossil Fuel Generating Stations: Eddystone, Cromby, and Schuylkill

Pre-Field Trip Preparation – 2-3 days

1. Use NEED's **Energy Source Expo** to have your students learn about all ten energy sources before visiting the power plant. An alternative is to divide your students into larger groups and choose to present on just non-renewable sources.

Post-Field Trip Reflection

Have students reflect on these questions in their science notebooks, and then discuss as a class.

7. What are your initial impressions from your visit to the power plant?
8. Explain how coal is used to generate electricity.
9. Explain how the natural gas and oil are used to generate electricity.
10. What advantages do natural gas and oil offer as a fuel source compared to coal and many renewables?
11. What is the difference between base load power generation and peak load power generation?
12. What questions do you have after visiting this power plant?

Options for Schools Not Participating in the Field Trip

NEED has created a list of DVDs that provide students with the opportunity to see and learn about energy facilities and energy infrastructure if they are not able to participate in the PECO Field Trip Experience. A list of these recommended DVDs can be found on the program website at www.need.org/peco.



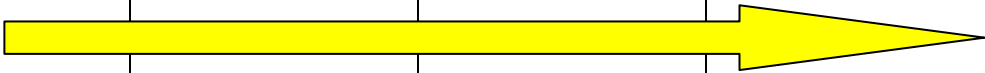
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2010-2011 Program Timeline

December 10-11	Teacher Training Workshop at the Franklin Institute
December 20	Field Trip Selected and Confirmed
December 20	Educational Audit Date Selected and Confirmed
December 12-April 30	Classroom Program, Field Trips and Community Project Underway PECO Team (PECO, FI, NEED) visits schools to see work and programming
January 11	Quick Check: Optional Conference Call with Sharon K., Susan H. and Mary S.: 4:30 p.m. 1-800-313-9166; Passcode 299835
January	Educational Energy Audits Underway
February 10	Quick Check: Optional Conference Call with Sharon K. and Mary S.: 4:30 p.m. 1-800-313-9166; Passcode 299835
March 10	Quick Check: Optional Conference Call with Sharon K. and Mary S.: 4:30 p.m. 1-800-313-9166; Passcode 299835
April 14	Program Update and Check-In: Successes, Challenges, Plans? Lead teachers participate in a conference call and submit one-pager review form via email.
April 30	Community Project Completed
May 5	Schools notified to prepare to present at PECO Energizing Education Celebration
Week of May 20	PECO Energy Education Celebration
May 30	All Evaluations submitted to NEED
June TBA	Participating school debrief at The Franklin Institute

Recommended PECO Energizing Education Planning Guide

<p>Day 1 Science of Electricity</p> <ul style="list-style-type: none"> Demonstration 	<p>Day 2 Introduction to Saving Energy</p> <ul style="list-style-type: none"> Students read to gain background knowledge about energy usage. 	<p>Day 3 School Building Survey</p> <ul style="list-style-type: none"> Students analyze their school's energy systems. 	<p>Day 4 Monitoring Tools</p> <ul style="list-style-type: none"> Students learn how to use monitoring tools 	<p>Day 5 Review, Change and Introduce</p> <ul style="list-style-type: none"> Review everything that has been learned this week and brainstorm changes that could be made. Introduce the Energy Outreach Projects, let students start brainstorming
<p>Day 6 Science of Energy</p> <ul style="list-style-type: none"> Introduction to Energy Forms Begin Station Rotations 	<p>Day 7 Science of Energy</p> <ul style="list-style-type: none"> Rotate Through Stations 	<p>Day 8 Science of Energy</p> <ul style="list-style-type: none"> Finish Stations if needed. Students are assigned to one station and read about what happened. 	<p>Day 9 Science of Energy</p> <ul style="list-style-type: none"> Reading to Understand Prepare presentations 	<p>Day 10 Science of Energy</p> <ul style="list-style-type: none"> Students present station understanding to each other.
<p>Day 11</p> <ul style="list-style-type: none"> Renewable Energy Sources 	<p>Day 12</p> <ul style="list-style-type: none"> Renewable Energy Sources 	<p>Day 13</p> <ul style="list-style-type: none"> Renewable Energy Sources 	<p>Day 14</p> <ul style="list-style-type: none"> Renewable Energy Sources 	<p>Day 15</p> <ul style="list-style-type: none"> Renewable Energy Sources
<p>Day 16</p> <ul style="list-style-type: none"> Renewable Energy Sources 	<p>Day 17</p> <ul style="list-style-type: none"> Renewable Energy Sources 	<p>Day 18</p> <ul style="list-style-type: none"> Renewable Energy Sources 	<p>Day 19</p> <ul style="list-style-type: none"> Renewable Energy Sources 	<p>Day 20</p> <ul style="list-style-type: none"> Renewable Energy Sources
<p>Day 21</p> <ul style="list-style-type: none"> Saving Energy Home Kits 	<p>Day 22</p> <ul style="list-style-type: none"> Saving Energy Home Kits 	<p>Day 23</p> <ul style="list-style-type: none"> Saving Energy Home Kits 	<p>Day 24</p> <ul style="list-style-type: none"> Mission Possible 	<p>Day 25</p> <ul style="list-style-type: none"> Mission Possible
<p>Day 21</p> <p>Energy Outreach Projects</p>	<p>Day 22</p>	<p>Day 23</p>	<p>Day 24</p>	<p>Day 25</p>



- This is a sample planning sequence for your PECO Energizing Education Unit. Due to the time frame of this project lessons are expedited. In the future, you may wish to delve deeper into these topics and investigations.
- Teachers should thoroughly review all materials and plan units according to the needs of their students and their classroom timing and sequencing.
- Not included in the above plan is a visit by NEED's Todd Rogers to work with a group of students on an Educational Energy Audit of the school.
- Link to NEED Standards Alignments: http://www.need.org/Standards/PA_NEED_correlations09.xls

PECO Energizing Education Recommended Pacing

Day 1: Science of Electricity

Activity: Demonstrate the Science of Electricity Model (From the Hydropower Teacher Guide, pg. 21-23), have students think about what could be used to turn the turbine. Students then read about generating electricity in their Infobooks.

Materials Needed: Science of Electricity Model which you should build prior to this lesson, voltmeter also included in the Hydropower Kit, Intermediate Energy Infobooks

Reading: Intermediate Energy Infobook, *Electricity*, pages 32-34

Science Notebooks: Draw and label the parts of the system, explain how a generator works, brainstorm what sources could be used to turn the turbine to generate electricity.

PA Science Standard: 3.1.7.A

3.1.10.B

Variation: You can have pairs or groups of students build their own science of electricity models. There are enough supplies for one Science of Electricity Model in the Hydropower Kit. There is enough copper magnetic wire for multiple models, but you will need to supply the following for each group: 2 bottles, 1 - 12" dowel, 1 rubber stopper, four strong magnets. There are many opportunities for students to investigate the system and how different inputs impact the electrical output.

After initial demonstrations have students think about what they still don't know, about parts of the system that could affect the whole if they were changed, and what experiments they would like to try to take their learning further. Encourage students to investigate their questions using the apparatus. Have them explore how varying amounts of magnetic wire, number of magnets, distance between the magnets and wires, speed of motion, type of motion, affects their generator. Have students imagine/design/try a way to power their generator with other energy sources besides human effort, such as water, wind, sun, animal power...be creative!

Day 2: Introduction to Saving Energy

Activity: **Monitoring and Mentoring Teacher Guide page 7** – Students are introduced to energy consumption, conservation, and efficiency. After brainstorming ways they use energy, students read more information to gain a foundation before conducting energy audits.

Students will be able to understand how energy is used at home and school.

Materials Needed: Monitoring and Mentoring Teacher and Student Guides

Reading: Monitoring and Mentoring Student Guide pages 3-8

Science Notebooks: Students list ways that they use energy in the classroom and at home. Students should record notes from reading. Optional: Make copies of the graphic organizers in the **Monitoring and Mentoring Student Guide pages 10-14** and have students record notes on these.

PA Science Standards: 3.1.7.E

3.1.10.E, 3.8.10.C

Day 3: School Building Survey

Activity: Students conduct a School Building Survey to further understand how their school uses energy.

Monitoring and Mentoring – Teacher Guide pages 31-32 and Student Guide pages 49-50

Students will be able to understand how their school uses energy.

Materials Needed: Copies of the School Building Survey (Student Guide pages 49-50)

Science Notebooks: Students should keep notes about their survey answers in their notebooks.

PA Science Standards: 3.1.7.E,

3.1.10.E, 3.8.10.C

Directions: Break students up into groups that will focus on each section of the School Building Survey. Have the groups research the answers either by physically looking at the system in question, or by talking to your school or district building manager. You may want to invite that person in to talk to your students, or ask if your students can email him/her with questions they cannot answer.

Day 4: Introduction to Using Monitoring Tools

Activity: Students learn how to use various energy management tools. Once they have read the directions students should be allowed to gather informal data around the classroom and/or building.

Students will be able to understand how tools are used to collect data about energy usage.

Materials Needed: Tools from the Monitoring and Mentoring Kit, copies of applicable pages from the Student Guide

Science Notebooks: Students draw a diagram of the tool they’ve been assigned and explain how it works. Students practice using the instruments and record data. Or, if students are conducting investigations then they should use the notebooks to record information and data related to their experiments.

PA Science Standards: 3.1.7.E

3.1.10.E, 3.8.10.C

Additional Information: Break students into groups to learn various monitoring tools/conduct investigations. Below is the break-down to have eleven small groups. If you would like larger groups you can combine or take out activities to meet your needs.

Groups	Teacher Guide Pages	Student Guide Page(s)
Reading Meters - Electric Meters - Natural Gas Meters	14-15	20-22 23-25
Insulation Investigation	12-13	26
Facts of Light - Facts of Light - Lightbulb Investigations - Light Meter - Flicker Checker	16-20 21-22	27-28 32-34 29-31 35
Electric Nameplates - Electric Nameplates - Cost of Machines - The Environment and You	23-24	36-37 38-39 40-41
Kill A Watt™ Monitor	29-30	45-48
EnergyGuide Labels	25-28	42-44

Day 5: Part 1 – Review Survey and Brainstorm Changes

Activity: Students share how their monitoring tools work, and the results of their investigations and surveys. Based on their learning students begin to think of changes that they could make to reduce energy use.

Students will be able to understand that changes can be made to be better energy stewards.

Materials Needed: Data and observations collected over past two days.

Science Notebooks: Students brainstorm changes that could be made, and the part they can play in making the changes happen.

PA Science Standards: 3.1.7.E,

3.1.10.E, 3.8.10.C

Day 5+: Part 2 – Energy Outreach (For more detailed information please see page 27 of this document.)

Activity: Students design and implement an energy outreach project that will share their new found ideas with some component of the community.

Students will understand that they can help inform the public and inspire changes to be made.

Materials Needed: Dependent on student projects. See grant requirements and description on page 3 and project ideas and planning pages starting on page 11 of this document.

Science Notebooks: Students can use science notebooks to make plans and sketch ideas.

PA Science Standards: 4.8.7.A-D
4.8.10.A-D

Days 6-8: Science of Energy Investigations

Activity: Students rotate through stations and use inquiry process skills learn about energy transformations within various systems. Each station will take approximately 20-30 minutes.

Students will understand that energy does not disappear, but changes from one form to another.

Materials Needed: Science of Energy Kit, Hot Water (Station One, Four, Five), and Cold Water, Copies of page 17 in the Science of Energy Guide for each student, Science Notebooks

Science Notebooks: In science notebooks students should draw and label the system at each station and record the energy transformation taking place.

PA Science Standard: 3.1.7.A, 3.1.7.E, 3.2.7.B, 3.2.7.C, 3.4.7.A, 3.4.7.B
3.1.10.A, 3.2.10.B, 3.2.10.C, 3.4.10.B

Additional Information: Prior to starting the rotations give each student a copy of page 22 from the Science of Energy Guide which they can fold in half and glue or tape into their science notebooks. Go over with them the different forms of energy. During their investigations students should label each energy transformation that they see taking place.

Station	Elementary Guide (4-8)	Secondary Guide (9-12)
One: Kinetic and Potential Energy	26-29	24-27
Two: Exothermic and Endothermic Reactions	30-34	28-34
Three: Radiant Energy	35-40	35-40
Four : Heat and Motion	41-45	41-45
Five: Chemical Energy	46-49	46-49
Six: Electricity	50-53	50-53

Students should record the question into their science notebooks and then answer as appropriate. Some stations are more complex and students will benefit from having the worksheets/procedures given to them. At other stations the students will be able to design their own investigations; offer as open an experience as your students can handle. As students investigate they should keep track of all relevant data and observations, surprises, real-world connections and thoughts in their science notebooks.

After each investigation students should reflect on what they observed by answering the questions, “What happened at the station? What energy transformations did you observe?” These questions should be provided to students so that they can refer back to them as they write their conclusions. Students should be encouraged to use evidence to support their thinking.

Day 9: Reading to Understand

Activity: Students are assigned to one of the Science of Energy stations. Using their science notebooks students will share their observations and what they think was happening at the station. Then they will read information from the Science of Energy Guide to confirm their thinking or change misconceptions. Students should be prepared to explain to their classmates what was happening in the next class session.

Students will understand why certain energy transformations occurred and how they work.

Materials Needed: Scripts for each Science of Energy Station.

Science Notebooks: Students use their science notebooks to share their data with peers. Then they write down new understandings and explanations based on their reading.

PA Science Standard: 3.1.7.A, 3.2.7.B

Day 10: Present Understandings

Activity: Groups teach their peers what was happening at each station.

Students will understand why certain energy transformations occurred and how they work.

Materials Needed: Science Notebooks

Science Notebooks: Students use their notes from their reading to explain what was happening at their assigned station. Students listening should take down notes in their science notebooks.

PA Science Standard: 3.1.7.A, 3.2.7.B, 3.2.7.C

Day 11-20: Renewable Energy Sources

Teachers will select two of the three renewable energy units to teach to their students.

**Each kit is individually designed as a one-two week unit. Teachers are encouraged to examine each kit and activities carefully and choose which lessons will best meet your objectives and the students' needs.*

Activity: Students will investigate energy from solar, wind, and water.

Students will understand how renewable resources are being used to generate electricity.

Materials Needed: Solar, wind, and hydropower kits, Science Notebooks

Science Notebooks: In conducting investigations students record their thinking, observations, and learning.

PA Science Standards: 3.1.7.A, 3.1.7.E, 3.8.7.B, 3.8.7.B, 4.2.7.B

3.1.10.A, 3.8.10.A, 3.8.10.C, 4.2.10.A, 4.2.10.B

Suggested Activities for Teaching Each Renewable Source

	Exploring Solar Energy	Energy from Moving Water	Energy from the Wind
Activities and Investigations TG = Teacher Guide SG = Student Guide	Radiant Energy TG: 8 SG: 11 Solar Concentration TG: 9 SG: 12 Solar Collection TG: 9 SG: 13 (14 is optional) PV/Solar House TG:10 SG: 15-16 Solar Oven TG: 10 SG: 17-18	Analyzing Electricity Flow TG: 7, 17-20 SG: 35 Measuring Electricity TG: 28 SG: 37-38 Magnets and Compasses TG:8 SG:41-42 ElectroMagnets: TG:9 SG:43-44 Force Investigations TG: 10 SG:47-51 Exploring Turbines TG: 11-12 SG: 52-57	Wind Speed Exploration TG: 8, 16-17 Wind Can Do Work TG: 9, 19-20 Observing a Genecon TG: 10, 21-22 Wind Blade Investigations TG: 11, 25-34
Background Reading (SG)	3-8	3-11, 12-25 , 26-28	3-17

Day 21-23: Saving Energy in the Home

Activity: By analyzing their own living and work spaces students apply what they have learned to making energy changes in their personal lives at school and home.

Students will understand how their actions affect energy consumption at home and at school, and that they can make changes to conserve energy.

Materials Needed: Saving Energy at Home and School Kits and Guide, Science Notebooks

Science Notebooks: Students should use their notebooks to document their current energy use and plan ways to conserve energy. There are many templates/worksheets in the guide that you may find helpful. These templates provide areas for students to analyze spaces they use and reflect on changes that can be made. You can make copies of the master pages and then have students glue or tape the page into their science notebooks. Students can trim the page to make them fit, or if the pages are one sided they can fold the page in half and glue the backside of one half of the page down.

PA Science Standards: 4.2.7.B, 4.8.7.C, 4.8.7.D
4.8.10.D

PA FCS Standards: 11.1.6.A, 11.2.6.E
11.1.9.A, 11.2.9.E

Additional Information: Some of this information will be a review of what was learned at the beginning of the unit. Now students are applying everything they've learned to their own homes. Students are encouraged to involve their families in these activities!

Most likely you will not be able to complete all activities within the time frame. Teachers should decide which activities will best meet the needs of their students and fit in the time they have.

Suggested Home Activities

Activity	Teacher Guide	Student Guide
The Energy I Used Today	12	7-8
Using Energy at Home	21	17-24
Home Survey Totals	22	n/a
Home Meter Reading	23-26	28-31
Insulation & Weatherization	28-29	33, 35
Heating and Cooling	31-32	36-39
Water Heating	33-36	40-44
Windows	37	45-48
Lighting	38-41	49-53
Appliances and Machines	42-45	54-59
Home Reflection	46	60-61

Day 24-25: Mission Possible

Activity: Students are challenged to develop an energy plan for a growing country. Students consider the advantages and disadvantages of the energy sources available to them to use so they can increase electricity production while maintaining environmental quality and quality of life.

Students will understand that energy plans require many different energy sources – there is no one solution to meeting our energy needs.

Materials Needed: Mission Possible Booklet, and appropriate copies for students, available to download at: <http://www.need.org/needpdf/Mission%20Possible.pdf>; Energy Infobooks

PA Science Standards: 3.8.7.B

3.8.10.B

Science Notebooks

Science notebooks are places for students to record their thinking. Over the course of this unit pages may get ripped, folded, or spilled on, and this is okay - it is a sign of a real scientist at work! There are many different looks to science notebooks, ways to use them, and ways to assess them. Below is a general rubric you can use to assess students' work in their Science Notebooks, or as a basis to design a rubric to meet your specific needs.

	Understanding of Concepts	Scientific Inquiry	Presentation
4	Students demonstrate thorough understanding of concepts through pictures, writing, and verbal communication.	Students are able to follow all steps of the scientific process independently: predict/hypothesize, observe/record data, and draw more complex conclusions related to their data. Students show higher level thinking by asking pertinent questions.	Handwriting is legible. Pictures are realistic and include labels. All parts of the assignment are complete.
3	Students demonstrate understanding of concepts through pictures, writing and/or verbal communication.	Students are able to predict/hypothesize, observe/record data, and draw a basic conclusion with some teacher support. Students begin to ask their own questions. May include some teacher support.	Handwriting is legible. Pictures are realistic and have labels for the most part. All parts of the assignment are complete.
2	Students demonstrate a beginning understanding of concepts, fewer major misconceptions remain.	Students require teacher support and/or are able to do two of the following independently: predict/hypothesize, observe/record data, draw conclusions. Students need prompting to think of their own questions.	Words and/or pictures may be hard to decipher at times. Pictures are present but are missing labels. The notebook has some missing components.
1	Students demonstrate confusion about concepts. Many misconceptions remain.	Students do not follow the scientific process independently and require significant support to do the following: predict/hypothesize, observe/record data, draw conclusions. Students are uncomfortable asking questions.	Words and/or pictures are hard to decipher. They may not be connected to the investigation. The notebook has many missing components.

Comparing Sources

Compare the electricity generation you learned about on your field trip to another power plant that produces electricity from a different source. In the box, list the similarities and in the t-chart list the differences.

Two sources I am comparing: _____

Similarities

Differences

Source 1	Source 2

Energy Outreach Project Assignment

Assignment: Put together a project that will demonstrate and share your findings about aspects of energy such as:

- What energy is, how it is generated and how that impacts your school/community/world.
- The many ways we use/consume/waste it.
- Energy usage as a quality of life issue in your community.
- Students as active citizens and stewards making informed decisions about energy use.

Your project should help others learn about energy, analyze their own energy usage, and inspire them to make changes that will have a positive impact.

Project Examples: Some ideas include

- putting on a Community Energy Fair/Carnival
- working with younger students to teach them about energy
- creating an energy news program to share online
- hosting family energy nights or events at school
- writing a plan to cut down on energy usage in your school or community and presenting this plan to officials.
- performing energy audits for other schools in your area and helping them make changes

But don't be limited by our ideas. BE CREATIVE!! The possibilities are endless!

Use the following planning page in order to help you get started.

Energy Outreach Brainstorm Page

Group Members: _____

Things we found interesting that we want to share with others: _____

Who do we want to share it with? _____

Three or more ways we could reach people in our community: _____

The idea we like best and why: _____

Materials/Resources we need: _____

Teacher Signature for Idea Approval: _____

Energy Outreach Planning Page

Steps to Implement Plan	Who is in Charge	Our Deadline

Teacher Signature for Plan Approval: _____

Sample Energy Outreach Rubric

	Understanding of Energy	Application of Learning	Project Effectiveness
4	Students communicate an awareness of a variety of ways that energy is generated and consumed.	Students demonstrate understanding that they affect energy systems in their daily choices.	Students' project helps others analyze their energy usage and encourages ways to bring about meaningful change.
3	Students communicate awareness of a 3-4 ways that energy is generated and consumed.	Students demonstrate understanding that they use energy.	Students' project helps people become aware of their energy usage.
2	Students communicate awareness of 1-2 ways energy is generated and consumed.	Students demonstrate some understanding that they affect energy systems.	Students' project informs people about energy.
1	Students are unable to communicate how energy is generated and or consumed.	Students are unclear that their actions affect energy systems.	Students' project is unclear or confusing as to how it relates to energy and/or energy conservation.

PECO Energizing Education Program – Teacher Evaluation – Return to NEED by May 30, 2011

I used this unit with _____ (how many) students in grade _____.

The students in my class were (circle all that apply):

On Grade Level

Below Grade Level

Gifted and Talented

ESL/ELL

Special Education

Please rate the statements using the 1 – 5 scale. If anything is a 3 or lower please give us specific comments so we can make improvements.

Rating Scale: 1-Strongly Disagree / 2-Disagree / 3-Uncertain / 4-Agree / 5-Strongly Agree

The professional development prepared me to facilitate the content.	1	2	3	4	5
--	----------	----------	----------	----------	----------

Comments:

The level of the content was appropriate for my students.	1	2	3	4	5
--	----------	----------	----------	----------	----------

Comments:

The equipment provided helped the students learn the desired concepts.	1	2	3	4	5
---	----------	----------	----------	----------	----------

Comments:

The activities were engaging.	1	2	3	4	5
--------------------------------------	----------	----------	----------	----------	----------

Comments:

My students remained interested and motivated throughout the program.	1	2	3	4	5
--	----------	----------	----------	----------	----------

Comments:

The program met my expectations.	1	2	3	4	5
---	----------	----------	----------	----------	----------

Comments:

Please respond to the following questions.

1. Were you able to complete all aspects of the program? If not, what did you leave out and why?

2. What field trip(s) did you participate in?

a. Did the field trip(s) meet your expectations?

b. Would you go on the same field trip(s) again? Why or why not?

3. Did students and their families feel like the home energy kits were useful?

4. Were your students able to complete the community outreach portion? Did the students feel like they were able to make a difference in the community?

5. What impact do you feel participating in the PECO Energizing Education Program had on your students?

6. What impact did participating in the PECO Energizing Education Program have on you?

7. What further professional development, if any, do you need to better present the content to your students?

8. Would you recommend participating in the PECO Energizing Education Program to others?

9. Do you have other comments/feedback to share with us?

Please Fax to: 1-800-847-1820

or

email to info@need.org

PECO Energizing Education Program – Student Evaluation – Return to NEED by May 30, 2011

What grade are you in? _____

Please rate the statements using the 1 – 5 scale. If anything is a 3 or lower please give us specific comments so we can make improvements.

Rating Scale: 1-Strongly Disagree / 2-Disagree / 3-Uncertain / 4-Agree / 5-Strongly Agree

I was interested in the topics covered in this unit.	1	2	3	4	5
Comments:					
I increased my understanding of energy sources.	1	2	3	4	5
Comments:					
I have a better understanding of how electricity is produced.	1	2	3	4	5
Comments:					
I understand that my personal choices at home and school affect the overall energy picture.	1	2	3	4	5
Comments:					
I believe I made an impact on the community through my outreach project.	1	2	3	4	5
Comments:					
The field trips gave me a better understanding of how electricity is produced.	1	2	3	4	5
Comments:					

1. What did you learn during the PECO Energizing Education Program that you didn't know before?

2. What part of the unit did you enjoy doing the most?

3. Did you share the energy conservation information with your family? Did you install the conservation measures from your home kit?



*Presented in partnership with The Franklin Institute and
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