Switch It!
Project Guide

THE PEGGY NOTEBAERT NATURE MUSEUM
The Museum of the Chicago Academy of Sciences

Chicago Conservation Corps

PROJECT NAME: Switch It!

PROJECT FOCUS: Energy conservation

INTRODUCTION: We live in an era when electricity is readily available to us at the flip of a switch. But for all the many ways we use electricity throughout the course of our daily lives, do we consider that every molecule of energy that is harnessed for human use comes at a cost?

In order to use the energy that is stored in fossil fuels, we have to burn them. Fossil fuels like coal are burned to heat up water, which makes steam to turn turbines in a power plant. The turbines then generate electricity, which powers our homes and schools. The problem is that burning fossil fuels like coal generates an enormous amount of carbon dioxide that is released into the atmosphere. All of this extra carbon dioxide is creating an imbalance in the Earth's atmosphere and shifting our climate – known as human-induced climate change. The more we use fossil fuels to power our lives, the more carbon dioxide is released, and the warmer our planet will continue to get.

Because most of the electricity we use originates from burning fossil fuels, it is of utmost importance that we use energy as efficiently as possible so that we can reduce the amount of carbon dioxide that is being released into the atmosphere to create that energy. But **do** we conserve whenever we can? According to the US Department of Energy, about 25% of the energy used in a typical school is wasted because of energy inefficiency! Everywhere we look, we see examples of energy waste: lights left on in unoccupied rooms; appliances left plugged in and on; cracks in windows that allow heat to escape; these are only a few examples of energy waste.

Not only C3s wasted energy come at a cost to environment – but also to our bank accounts. In the 2007 financial year, the Chicago Public School district allocated $83.3 million for energy costs. If 25% of energy in these schools was wasted, it equates to **over $20 million** was wasted on energy inefficiency! And over the past decade, energy prices have been consistently rising, making it ever more important to conserve however we can.

Over the course of this project, you will be addressing this issue of energy efficiency, encouraging your fellow students, teachers, administration, and even families to conserve energy in their everyday lives. Your Club will be gathering data about energy use in your school, and using it to launch a Community Conservation Challenge. All results and final data – from the audits to the Challenge – will be presented in a venue of your choice to educate and remind your entire school community about energy conservation, and the importance it has for the health of our planet

MATERIALS:

General C3 Club Action Project supplies:

- 4 packs of low-odor markers
- 1 ream of assorted recycled paper (8.5" x 11")
- 10 recycled-paper posterboards
- 2 rolls of tape
- C3 Club Network Supplies *(distributed at Kickoff Meeting on 9/9 or 9/17)*

Project specific materials (provided):

For Phase I:

- 1 Kill-A-Watt meter

For Phase II:

- Light switch stickers
- power strips

For Phase III:

- One smart strip outlet
- Light switch stickers
- Power strips
- CFL bulbs (or another outreach tool)

For Phase IV:

- 1 Kill-A-Watt meter (from Phase I)

Materials for teacher to provide:

- Box of packing peanuts
- Clipboards / pencils
- Additional art supplies
- Calculators

OBJECTIVES:

1. Trace energy through a system / classroom / school back to the sun.
2. Calculate the kWh of energy used by school appliances.
3. Conduct a "Who Left the Lights On?" Audit for your school.
4. Complete an ecological footprint survey at www.globalfootprintnetwork.org
5. Install simple measures throughout your school to conserve energy and calculate the savings.
6. Educate your school and surrounding community on conservation, using materials like switchplate stickers, weatherization kits, and CFL bulbs.

PERFORMANCE MEASURES:

The success of your project will be tracked with several performance measures. These measures are designed so that you will have quantitative successes to report at the end of your project. Part of Phase I: ("Learn") is to audit or assess the current situation of these measures at your school, then to set goals to accomplish by the end of the year. In Phase IV ("Thinking Back & Looking Ahead"), you will re-assess the situation to track the difference that your project has made.

	Performance Measure	**Current Amount** (measure during Phase I)	**End-of-the-Year Goals** (set during Phase I)	**Final Amounts** (measure during Phase IV)
1	Number of students actively involved in your C3 Club			
2	Percent of classrooms in the school that leave their lights on when nobody is using the space			
3	Number of light switch stickers installed			
4	Number of power strips installed and actively used (turned on only during peak usage)			
5	Number of CFLs distributed			
6	Number of families attending the Community Conservation Challenge Event			
7	Number of pledge forms collected			

PROJECT TIMELINE, MILESTONES, AND REPORTING:

This timeline is designed to give you milestones to guide you in your project development, implementation, and evaluation. At the end of each project phase, you will submit an online report (4 total reports), where you will sign off on having completed each of the milestones below. Remember that this timeline is just a starting point to plan your project, which you will tailor to address the needs of your individual school community.

To fill out your online report, sign in to the "C3 Teachers" section of the blog at www.chicagoconservationcorps.org. Please be sure to submit your report on time, even if you have not yet completed all of the milestones. Remember that teacher stipend checks are contingent on the timely completion of reports. Due dates are listed for each phase.

Phase I: Learn

October 12 -December 4

Online Report Due: Friday, December 4

- ☐ MILESTONE #1: **Meet with administration** to get permission to conduct the "Kill –a –Watt" and "Who Left the Lights On?" Audits.
- ☐ MILESTONE #2: **Gather/Recruit C3 Club members** and discuss with them what their project will be for the school year. Solicit their input and ideas.
- ☐ MILESTONE #3: Do the **Energy Flows Demonstration** (see Appendix).
- ☐ MILESTONE #4: **Trace energy** through different pathways.
- ☐ MILESTONE #5: Conduct the "**Who Left the Lights On?" Audit.**
- ☐ MILESTONE #6: **Calculate results** and fill in performance measures chart. **Set goals** for the end of the project.
- ☐ MILESTONE #7: **Complete Online Report:** Due December 4.

Phase I Procedures:

- **Read through the steps outlined for Phase I, and contact C3 with any questions. Please note: These milestones can be adapted so that they most effectively meet the needs of your individual school community; however, please communicate any major changes to C3 staff early on in the process.**

MILESTONE #1: Meet with administration to get permission to conduct the "Kill –a –Watt" and "Who Left the Lights On?" Audits.

- **Teachers and/or students meet with the principal, science coordinators, and the supervisor of building operations** to discuss the project and to ask for their support, feedback and possible assistance in providing additional information (what lights are supposed to be left on…etc.) before student work begins.

- **Teachers should get permission at least one week prior** to the first club audit meeting.

MILESTONE #2: Gather/Recruit C3 Club members and discuss with them what their project will be for the school year. Solicit their input and ideas.

MILESTONE #3: Conduct the Energy Flows Demonstration (directions in the Appendix) **(<1 meeting)**

- **Energy flow is hard to see because energy is not visible.** Sometimes it is unclear how the energy from the sun is flowing through all systems natural and unnatural. In this demonstration, several major concepts about energy become clear and obvious:

1. Producers get the most energy, i.e., the most packing peanuts.
2. As energy travels, it diminishes and some is lost as heat, i.e., packing peanuts are dropped along the chain and become unavailable for the next in line.
3. The lost energy (dropped peanuts) is trapped in our atmosphere by CO_2 and other greenhouse gases and cause the temperature of Earth to rise.
4. If we, as humans, are some of the last in the chain, we are receiving the least amount of energy. How much more important is it then that we take care of or conserve the energy we do receive so that we are being good stewards of our supply?

MILESTONE #4: Trace Energy Pathways (<1 meeting)

- **Have students name things that require energy** (e.g., anything living, anything motorized, etc.) Have students name things that emit energy (e.g., light bulbs, heating units, etc.)

- **Write all answers in a list on the board**. Use the overview below for guidance.

Energy Use – Overview

- Schools use a lot of energy! In the 2007 financial year, the Chicago Public School district allocated $83.3 million, or about 2% of its total budget, for energy costs. According to the US Department of Energy, about 25% of the energy used in a typical school is wasted because of energy inefficiency.

How is Energy Being Used in Your School? Here are some Examples:

Classrooms	Offices	Kitchen	Miscellaneous
Lights	Lights	Dishwashers (use hot water)	Vending Machines
Computers	Computers	Refrigerators,freezers	Water Coolers
Monitors	Monitors	Steam cookers, friers, etc.	Exit signs
Printers	Printers	Stoves, food warmers	Fans
TVs	Copiers		Kilns
VCR/DVD players	Fax machines	Restrooms:	Hot water heaters
Overhead projectors	Scanners	Lights	Escaping through
Leaky doors and windows	Leaky doors and windows	Faucets and showerheads (use hot water)	doors left open/ cracks in windows
Heating/Cooling	Heating/Cooling		

- **Explain that all energy, anywhere and everywhere, comes from the sun**. Challenge students to each take one of the items on the board and write out its energy pathway. Read aloud and ask Club members if all steps were included. All members should tackle one pathway.
- **Lead students back through the energy pathway of the items in your list**. For example: Light bulbs → Electricity → Power plant → Fossil fuel (coal in IL) → decayed plants and algae → were once living and received energy from the SUN!
- **Refer back to the introduction for more information.**

MILESTONE #5: "Who Left the Lights On?" Audit (1 meeting)

- **Arrange students into groups that will work on the "Who Left the Lights On?" Audit**. There should be 2-3 students in a group. Each group can be assigned a certain area (a series of classrooms, a hallway, a floor, etc.) of the school to conduct their audit. Students will fill out columns A-C in their small groups. The same students will revisit the same area for the second audit during Phase IV.
- **See Appendix for the Data Sheet.**

MILESTONE #6: Calculate results (1 meeting)

- **Complete the remaining columns (D-I) on the calculations worksheet.**
- **As a group, fill in the "Current Amount"** column of your Performance Measures chart on page 3. Also, set your "End-of-the-Year Goals" based on your initial work.

MILESTONE #7: Complete online report for Phase I, due Friday, December 4.

Phase II: Act

December 7 – February 26
Online Report Due: Friday, February 26

- ☐ MILESTONE #8: **Discuss the Kill-A-Watt project tasks** with C3 Club members.
- ☐ MILESTONE #9: Use the Kill-A-Watt device to **measure energy use** of school appliances.
- ☐ MILESTONE #10: **Record and calculate data** from the Kill-A-Watt Audit (see Appendix).
- ☐ MILESTONE #11: **Make posters, graphs, pointers post-its, and fact sheets** to raise awareness about efforts to increase energy conservation in school.
- ☐ MILESTONE #12: **Use switchplate stickers** to encourage your school to turn off lights when not in use.
- ☐ MILESTONE #13: **Use power strips** to educate the school about phantom energy load, and the importance of "switching it off!"
- ☐ MILESTONE #14: **Meet with custodial staff or the building operations manager** to hear about existing energy saving measures and discuss new initiatives.
- ☐ MILESTONE #15: **Complete Online Report:** Due February 26.

Phase II Procedures

☐ **Read through the steps outlined for Phase II, and contact C3 with any questions. Please note: These milestones can be adapted so that they most effectively meet the needs of your individual school community; however, please communicate any major changes to C3 staff early on in the process.**

MILESTONE #8: Discuss the Kill-A-Watt project tasks with C3 Club members.

- ☐ Review the "How to *Kill-a-Watt*" Activity Guide with Club members. Each Club member should receive a double-sided copy of the guide and activity worksheet.
- ☐ Club members should form small groups (2-3 students per group) which will be responsible for auditing different areas of the school (specific classrooms, hallways, floors, etc.).

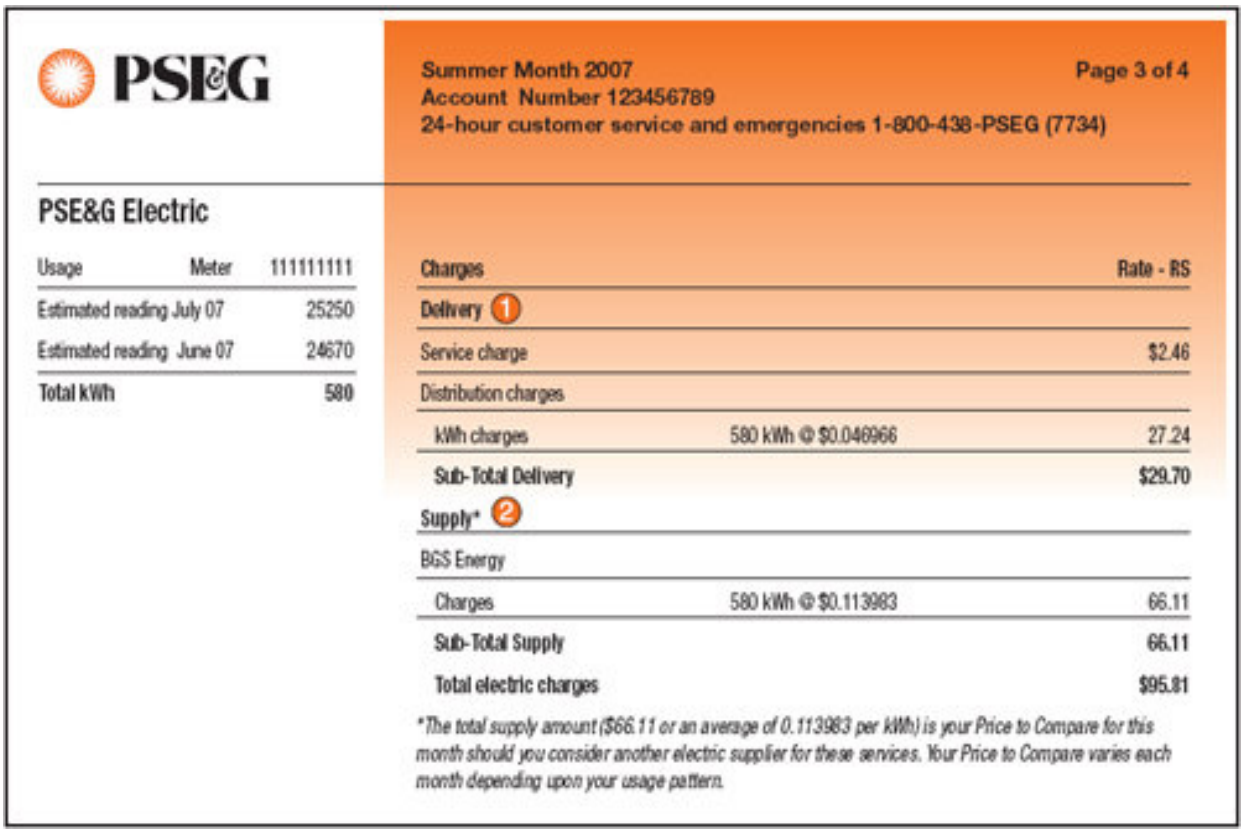
MILESTONE #9: Use a Kill-A-Watt device to measure energy use.

- ☐ **Begin installation**. After student groups know which appliances they will be measuring, have them take their meters to each appliance for installation. You will likely need to work out a schedule because your Club only has access to two Kill-a-Watt meters – students will need to take turns.
- ☐ **Place a note or sign on or near the appliance.** Explain that it is under observation for its energy (kilowatt hour) consumption and should not be unplugged.
- ☐ **Use of the appliance should be as usual** for at least 2 full school days.
- ☐ **Gather data for column A of your worksheet.** Turn off the appliance completely. Look at the Kill-A-Watt device screen. Press the purple button to see how many kilowatt-hours of electricity were used by the appliance(s). Record this number in column A of the How to Kill-A-Watt Calculations Worksheet (Appendix).
- ☐ **Gather data for column B of your worksheet.** Press the purple button again to display the amount of time that has passed since you plugged the appliance into the kill-a-watt device. Record this number in column B of the Calculations Worksheet. Round to the nearest half hour and write in decimal form. For example, write 2.5 hours instead of 2:30 hours.
- ☐ **Uninstall the meters**. Once both numbers are recorded, be sure the appliance is completely off, unplug the appliance and the kill-a-watt device. Plug the appliance back into the wall.
- ☐ **Repeat** the process for another appliance or two according to your club's original plan.

MILESTONE #10: As a group complete the calculations based on the data collected. See Appendix.

- ☐ The bill shown on the next page is a sample electric bill for a residence in the summer months. There are two types of charges: The cost per KWh to deliver the electricity (1), and the cost per KWh to supply a home with electricity (2).

  Your Kill-A-Watt meters are measuring the supply of electricity to the appliance. Based on the bill below, the cost per KWh is $0.113983 (approximately what CPS pays for its electricity). Use the "How to Kill-A-Watt" calculations worksheet to estimate how much money is used every year to run the appliance. Then, calculate how much CO_2 is released into the atmosphere as a result of the appliance.



PSE&G

Summer Month 2007 Page 3 of 4
Account Number 123456789
24-hour customer service and emergencies 1-800-438-PSEG (7734)

PSE&G Electric

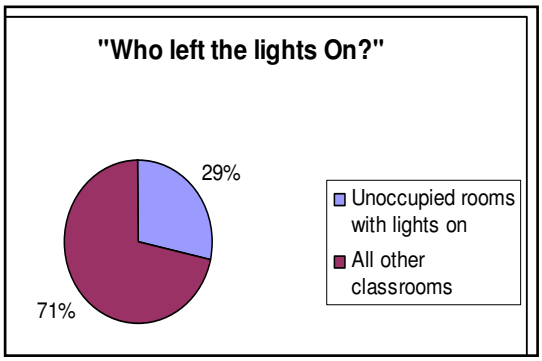
Usage	Meter	111111111
Estimated reading July 07		25250
Estimated reading June 07		24670
Total kWh		580

Charges		Rate - RS
Delivery 1		
Service charge		$2.46
Distribution charges		
kWh charges	580 kWh @ $0.046966	27.24
Sub-Total Delivery		$29.70
Supply* 2		
BGS Energy		
Charges	580 kWh @ $0.113983	66.11
Sub-Total Supply		66.11
Total electric charges		$95.81

*The total supply amount ($66.11 or an average of 0.113983 per kWh) is your Price to Compare for this month should you consider another electric supplier for these services. Your Price to Compare varies each month depending upon your usage pattern.

- **Present results to your club**. Data from each appliance will tell a different story about the energy load it carries. Students should share what they learned so that all are informed as to the changes that can be made. For example, some appliances might benefit more from having a power strip if their KwH usage is far more than other appliances.

MILESTONE #11: Educate others



- **Create visual displays of the data collected from the "Who Left the Lights On?" Audit**. Pie charts are perfect for displaying percentage data. For the "Who Left the Lights On" Audit, students can draw pie charts for display around the school. For example, one pie chart might show the percent of lights left on in occupied rooms versus percent of rooms with lights on and in use or lights off.
- **Present the Kill–A–Watt Audit findings.** Students can make posters, table tents, and fact sheets with graphs and graphics depicting their results. Challenge the students to frame their information in a "how much we could save" view. Each appliance could have a 'Pointers Post-It' on or near it so that users would be informed of the club findings and suggestions for energy conservation.

MILESTONE #12: Switch it!

- **Decorate and install light switch plate stickers** especially for the perpetrators of the "Who Left the Lights On?" Audit.
- **Resolve other issues** that might prevent students/teachers/staff from turning off the lights, especially at night.

MILESTONE #13: Power down with power strips.

- **Decorate power strips with energy saving directions for use:** "Please switch off the entire strip on evenings, weekends, and holidays. 15% of electricity bills go towards paying for phantom energy. Power down by switching off a power strip and save money, electrical energy, and fossil fuels; protect the atmosphere from more CO_2.
- **Install power strips** in the Club classroom and in strategic phantom energy load locations. An essential part of this process is using the power strips to *educate* your community about phantom load, and offering them the power strips as a *tool* to use in combating this problem. Installing the strips around your school yourself will save some power – but using them to *teach* others to save power will make a community-wide difference.
- **Use your Smart Strip as an educational tool.** Smart Strips are an advanced type of power strip that can be used for a cluster of related electronic equipment, such as a computer, speakers, printer, and monitor. By plugging the computer into the main outlet of the Smart Strip, the Smart Strip circuits can sense when power is flowing through them. When you turn off the computer, the Smart Strip will automatically shut off power to all of the other electronic equipment plugged into it, eliminating phantom load.

MILESTONE #14: Guest speaker(s).

- **Invite custodial staff** or the **building operations manager** to a meeting to discuss with students what Chicago Public Schools require them to do to save energy, what they actually do at the school to save energy, and to brainstorm together what changes can be made.
- **Present some of the solutions** you have generated for energy savings and ask those attending the meeting to think about the most viable options for your school.
- **Invite** the principal, board members, and any other administrators to a separate club meeting and present all findings, installations, and future ideas.

MILESTONE #15: Complete online report for Phase II, due Friday, February 26.

Phase III: Make a Difference

March 1 - April 23

Online Report Due: Friday, April 23

- ☐ MILESTONE #16: **Draft a script** for an all-school announcement about your energy campaign and to introduce the Community Conservation Challenge Event
- ☐ MILESTONE #17: **Make an all-school announcement**.
- ☐ MILESTONE #18: **Hand out pledge forms ahead of time.**
- ☐ MILESTONE #19: **Prepare presentation materials** of C3 Club discoveries and successes for the Challenge Event.
- ☐ MILESTONE #20: **Plan the challenge event** – administrative permission, location, additional advertising, supplies, volunteers, assigning Club responsibilities, etc.
- ☐ MILESTONE #21: **Implement the Community Conservation Challenge Event** – Raffle off smart strip and/or other outreach tools. Collect pledge forms from all present.
- ☐ MILESTONE #22: **Calculate savings based on pledge forms collected at the Challenge Event.**
- ☐ MILESTONE #23: **Complete Online Report:** Due Friday April 23.

Phase III Procedures

- **Read through the steps outlined for Phase III, and contact C3 with any questions. Please note: These milestones can be adapted so that they most effectively meet the needs of your individual school community; however, please communicate any major changes to C3 staff early on in the process.**

  MILESTONE # 16: Draft a script for an all-school announcement about your energy campaign and to introduce the Community Conservation Challenge Event.

- **Write a script.** Have students work together to draft an all school announcement about the work they have done and the work they want the entire school community to do to conserve energy. Every Club member should get a chance for his or her voice to be heard. Things to consider are:

- **Role:** What purpose should the announcement serve?
- **Audience:** Who do you want to pay attention? Who do you want to motivate?
- **Facts:** Are there any statistics or data that you could include to emphasize your point?
- **Tone:** Stay positive! "This is what we can do!" is received better than "You waste this!"
- **Specifics:** What action will you be taking, what actions do you want others to take? When? How? Where?

☐ **Embellish your announcement**. Think of this as a public service announcement or even a commercial. Brainstorm a 'catch phrase.' Music can be chosen to set an energizing tone.

MILESTONE 17: Make the announcement.

☐ **Plan ahead.** Get permission from the administration, then set a date and time to make the announcement. Be sure to do a practice announcement at least a day before the actual announcement.

MILESTONE 18: Hand out pledge forms ahead of time.

☐ **Create pledge forms.** Compose a pledge form as a Club. It could include: statistics from Club research as to why families might install a $3 power strip and switch it off when it's not in use, the cost of wasted electricity per KWh, the connection between energy conservation and decreasing greenhouse gas emissions, etc.

- **Remember that numbers are important**. Try to create a pledge form that specifies an amount of energy people might save by taking a specific action. For example, how much energy is saved by turning a computer off overnight (for at least 8 hours), unplugging a coffee maker, switching to CFLs? Per day? Per month? Per year? Look at the $800 Savings Challenge (a part of the Chicago Climate Action Plan) at www.chicagoclimateaction.org to get ideas, or use your Kill-a-Watts to make an estimate so that you can calculate energy, money, and greenhouse gases saved as a result of people's pledges.

☐ **Copy and distribute pledge forms** to your intended audience for the Community Conservation Challenge event. They will serve as "tickets" to the event.

MILESTONE 19: Prepare presentation materials of C3 Club discoveries and successes for the Challenge Event.

☐ **Use data collected to make presentation materials for the Community Conservation Challenge Event.** Brainstorm content for the display, performance, or presentation for parents and families at the event. Select ideas and assign roles to Club members for the event.

☐ **Be sure to set a deadline** for material preparation and a date for the event.

MILESTONE 20: Plan the challenge event – administrative permission, location, additional advertising, supplies, volunteers, assigning Club responsibilities, etc.

- **Plan when your event might take place.** Here are some ideas: report card pick up, open house, science fair, family night, faculty meeting /inservice, or lunch hours.
- **Ask permission** to present Club findings at whichever venue the event will be held. Reserve rooms, tables, etc. if necessary.
- **Advertise** for your event. This might involve your pledge forms in some way.
- **Secure** needed supplies – try to find a way to integrate as many C3 supplies as possible, particularly for outreach.
- **Perform, display, and discuss your presentation** at a Club meeting well in advance of the event to practice.
- **Make sure everyone understands their responsibilities** for the day of the event.

MILESTONE 21: Implement the Community Conservation Challenge Event
Raffle off smart strip and/or other outreach tools. Collect pledge forms from all present.

- **Students will collect the pledge forms** at the Challenge Event.
- ☐ **Club members will present all materials, findings, data** in their chosen format for all attending the event.
- ☐ **Raffle off** smart strips, unused switch plate stickers, and/or other outreach materials. It will be important to explain why these things are key to conserving energy.

MILESTONE #22: Calculate savings based on pledge forms collected at the Challenge Event.

MILESTONE #23: Complete online report for Phase III, due Friday, April 23.

Phase IV: Thinking Back & Looking Ahead

April 26 – May 28

Online Report Due: Friday, May 28

- ☐ MILESTONE #24: **Re-conduct "Who Left the Lights On?" Audit.**
- ☐ MILESTONE #25: **Fill in performance measures for 'Final Amounts' as a Club.**
- ☐ MILESTONE #26: **Report results of pledge forms and audit to your community.**
- ☐ MILESTONE #27: **Complete Online Report:** Due Friday, May 28.

Phase IV Procedures:

- **Read through the steps outlined for Phase IV, and contact C3 with any questions. Please note: These milestones can be adapted so that they most effectively meet the needs of your individual school community; however, please communicate any major changes to C3 staff early on in the process.**

MILESTONE #24: Reconduct the "Who Left the Lights On?" Audit

- **Perform a second audit**. In science it is important that variables in observation are limited. Try to repeat the steps you performed in the original audit as closely as possible.
- **Record all results in a second calculations worksheet**. As you go along filling in calculations, highlight the data points that stand out or are different from your first observation.

MILESTONE #25: Fill in performance measures for 'Final Amounts' as a Club.

- **Reflect with students**. Ask:
  - What do you now know about the connection between conservation of electrical energy that you didn't know before?
  - Can you explain why all energy comes from the sun? Or why if it is perpetual, do we need to conserve it?
  - Were the steps we took to reach our conservation goals practical? How will you tell others to conserve energy?

MILESTONE #26: Report results of pledge forms and audit to your community.

- Make another school announcement, make a poster, or send out a newsletter sharing the results of your Clubs efforts with everyone who helped you.
- Try to give them additional ideas for how they can have an even greater impact!

MILESTONE #27: Complete online report for Phase IV, due Friday, May 28.

CLUB ACTION PROJECT WORKSHOPS*

**Attendance is mandatory for at least one teacher representative per school. Dinner will be provided. Workshop Location: Chicago Center for Green Technology, 445 North Sacramento Blvd.*

- October 6, 4:30 – 7:30 p.m.
- December 8, 4:30 – 7:30 p.m.
- March 9, 4;30-7:30 p.m.
- April 27, 4:30 – 7:30 p.m.

ADDITIONAL RESOURCES:

C3 Year One Project Guides to Refer Back to:

- Air and Energy Audit

Online Resources

- Pew Center on Global Climate Change: http://www.pewclimate.org/. An informative, reliable source on climate change.
- EPA's Indoor Air Quality Tools for Schools: http://www.epa.gov/iaq/schools/. More information about what indoor air quality issues and solutions.
- C3's Residential Energy Assessment Program (REAP): http://webapps.cityofchicago.org/ERC/. Find out how to conduct an energy audit of your own home.
- Energy Star school page: http://www.energystar.gov/index.cfm?c=k12_schools.bus_schoolsk12 (from the Energy Star homepage, click on Buildings & Plants and under "Getting Started For…" on the left, select K-12). Learn more about energy-saving technologies for schools.
- US Department of Energy's Tips on Saving Energy & Money at home: http://www1.eere.energy.gov/consumer/tips/index.html
- Clean Air Counts, a non-profit campaign that works to improve indoor and outdoor air quality in Chicago: http://www.cleanaircounts.org/households/index.php

PROJECT APPENDIX

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Energy Flows Demonstration

Lesson Summary

Students take the role of organisms in a very large food chain or web. Packing peanuts are used to represent solar energy. Students will stand in line and wait for their portion of solar energy as it is delivered from the organism before them in the chain. Pieces of solar energy (packing peanuts) will decrease in number as they approach the end of the chain. Some of the energy (packing peanuts) will end up being dropped, or lost as heat. This models the actual flow of energy in living systems.

Time Allotment: 30 minutes

Materials per group
- One large box of packing peanuts

Advance Preparation
Arrange students in one long chain or several smaller chains.

Assign one student or the first student in the chain(s) to be the "plant" or producer.

Lesson Objectives

- Identify the sun as the source of ***all*** energy on Planet Earth.
- Understand that plants are the link to the solar energy.
- Explain how the amount of energy decreases as it flows through living systems.
- Discuss that energy can be lost as heat as it flows.

Vocabulary

Conservation	Consumers
Food chains	Food webs
Heat	Producers
Solar energy	Thermal energy

Background Information

Everything in nature or the environment is connected. The connection to the Sun is one of the most important to understand. Energy from the sun is called **solar energy.**

All energy on Earth originates with the sun. It is the diversity of plant species that can harness this energy and make it available for living systems. This is why plants are called **producers**. They are some of the unique organisms that can directly produce usable energy (glucose) from solar energy. They are always first in a **food chain** or **food web.** They are then consumed by plant eating organisms. These organisms and all organisms following are known as **consumers**.

Even though the energy from the sun is being captured by producers and transferred to consumers, not all of the energy makes these transitions. Some is lost. Usually, this lost energy is called **thermal energy** or **heat**.

In our demonstration you will use packing peanuts to demonstrate solar energy. Only designated 'plants,' the first people in line, can capture this energy. They, in turn, will pass it to the next in line, a consumer. This passing continues until the energy has reached the last one in line. By counting the number of packing peanuts the first and last people receive, the process of energy flow will be demonstrated.

Conservation is the act of handling resources, energy, etc. in a sustainable way. After the demonstration, it will become clear why conservation is necessary to sustain living systems, especially humans.

Energy Flows Demonstration

Initial Discussion

1. Ask students if they use energy and how.

2. Write their ideas about personal energy use on the board.

3. Discuss that all energy comes from the sun. Prove it by tracing back the light energy in the room comes from electricity generated by burning coal or fossil fuels that were once living algae, plants, etc. that got energy from the sun.

4. Do other examples if necessary.

Hands-On Activity

5. Dump a box of packing peanuts on the ground and explain that they represent energy from the sun.

6. Arrange students in one line or several small lines around the pile of packing peanuts.

7. Assign one student as the plant or producers for the chain / web.

8. This student can begin capturing solar energy. They should count how many packing peanuts they have. Record.

9. Allow producers to capture energy 5 times and each time pass to the next in line.

10. Have final consumer count the amount of solar energy they received. Record.

11. Discuss with students that as energy flows it decreased and can be lost as heat.

12. Ask students what becomes clear about energy flow.

Relate Activity to Concept

13. How much energy was there at the end of the chain?

14. Where are humans on the food chain / web?

15. How might conservation of energy help other organisms or systems?

16. The producers always get the most energy i.e. the most packing peanuts.

17. As energy travels, it gets less and less and some is lost as heat i.e. packing peanuts are dropped along the chain and become unavailable for the next in line.

18. The lost energy (dropped peanuts) is trapped in our atmosphere by CO_2 and other greenhouse gases and cause the temperature of Earth to rise.

19. If we, as humans, are some of the last in the chain, we are receiving the least amount of energy. How much more important is it then that we take care of or conserve the energy we do receive so that we are being good stewards of our supply?

Variations

- Also count the number of peanuts lost / dropped

Assessments

Have students graph the number of packing peanuts captured, lost, and remaining for each round.

"Who Left the Lights On?" Audit Data Sheet

Switch It! Club Action Project – Chicago Conservation Corps (C3) Student Clubs

1. *With your assigned team walk around your designated area of the school. Record the data in columns A-C. Note: "R.O." stands for "room occupied." If a room is occupied, it won't be included in your calculations because the energy there is being put to good use!*
2. *Return to your Club meeting. In your small groups, calculate columns D-F.*
3. *Work with the other groups in your Club to calculate columns G-I.*

A. **Room # / Location**	**B.** **Lights? ON, OFF, or R.O.**	**C.** **Time**	**D.** **# of unoccupied rooms with lights on.** *("ON" in column C.)*	**E.** **# of rooms audited.** *(Count rooms in column A.)*	**F.** **% of rooms with lights left on in your area** (*D. / E.)*	**G.** **Total # of unoccupied rooms with lights on** *(Add up all groups' column D.)*	**H.** **Total # of rooms in school** (*Add up all groups' column E)*	**I.** **% of rooms with lights left on in school** (*G. / H.)*

"How to *Kill-a-Watt*" Activity Guide
Switch It! Club Action Project
Chicago Conservation Corps (C3) Student Clubs

Every day, we all use energy. But how much? During this activity, you'll find out much electricity is used in your classroom by the things that you plug in. Electricity is measured in units called kilowatt-hours (kWh). Your **"Kill-A-Watt Electricity Usage Monitor"** will measure how many kilowatt-hours are being used when you plug something in.

Use the **"Kill-A-Watt"** to measure how much electricity is used by 3-5 different appliances. Choose appliances that are used on a frequent or ongoing basis, such as computers, monitors, and fax machines.

1. Choose an appliance with your teacher.
   - When choosing appliances, keep an eye out for the "Energy Star" symbol. This is like a "Gold Star" for energy efficiency. Buying new products that have the Energy Star symbol means you'll save both energy and money.
2. Turn the appliance off completely, then unplug it.
3. Plug the **"Kill-A-Watt"** into a socket or extension cord where it is secure and will not jiggle. Then, plug the appliance into the **"Kill-A-Watt."**
4. While the **"Kill-A-Watt"** is plugged in, take a look at the screen and try out some of its features.
   - Press the "Watt" button to see how many watts of electricity are being used.
5. Look at how much power it is using when the appliance is on, and then when it's off.
   - Even when a plugged-in appliance is turned off, it still uses electricity. This is called the *phantom load*. (The **"Kill-A-Watt"** might not detect this because it is a very small amount). You can reduce your phantom load and conserve electricity by unplugging appliances when you're not using them, or by plugging them into a power strip and switching the powerstrip off when the appliances are not in use.

6. Use the appliance as usual for at least 2 full school days.
7. After at least 2 full school days, turn the appliance completely off again, and take a look at the **"Kill-A-Watt"** screen.
8. Press the purple button to see how many kilowatt-hours of electricity were used by the appliance. Write this number down in **Column A** of the attached **Calculations Worksheet.**
9. Press the purple button again to display the amount of time that has passed since you plugged in the appliance. Write this in **Column B** of the **Calculations Worksheet** (round to the nearest half hour, and write in decimal form – example, write 2.5 hours instead of 2:30 hours).
10. Once you've recorded these two numbers, be sure the appliance is completely turned off, unplug the appliance and the **"Kill-A-Watt,"** and plug in the appliance to the wall again. Make sure you leave everything as you originally found it!
11. Measure at least two more appliances and record your observations.
12. Fill out the rest of the **Calculations Worksheet** with the help of your teacher. Explanations are on the worksheet.

SPECIAL CHALLENGES

- When choosing appliances, try to find an Energy Star appliance and a comparable non-Energy Star appliance, and compare the difference. For example, compare two computer monitors, one with the Energy Star rating, and one without.
- Even though the Kill-a-Watt cannot easily measure one appliance's phantom load, that doesn't mean you *can't* do it creatively! Try plugging a power strip into the Kill-a-Watt. Then plug several of the same appliance (e.g., lamps, projectors, etc.) into the power strip. Make sure ALL appliances are turned off and remain off (but plugged in) for a few days. See how much energy has been used by these inactive appliances in that period of time – that is a measure of phantom load.

"How to *Kill-a-Watt*" Calculations Worksheet
Switch It! Club Action Project – Chicago Conservation Corps (C3) Student Clubs

Appliance and Location	A. # of kWh used by appliance	B. # of hours appliance was plugged into Kill-A-Watt	C. Avg. # of kWh per hour used by appliance (A/B)	D. Avg. # of kWh per day used by appliance (Cx24)	E. # of kWh / schoolyear used by appliance (Dx180)	F. Cost of electricity cost per kWh	G. Cost per schoolyear to run appliance (ExF)	H. Pounds of carbon emitted per kWh in Illinois	I. Carbon emitted per schoolyear by appliance (ExH)**
Example: *Energy Star Computer Monitor, Classroom 126*	*5.3*	*48*	*0.1104*	*2.65*	*477*	**$0.07**	*$33.39*	**1.556**	*742.212*
1.						**$0.07**		**1.556**	
2.						**$0.07**		**1.556**	
3.						**$0.07**		**1.556**	
4.						**$0.07**		**1.556**	

**The electricity used by the appliance was mostly made by burning coal. This emits carbon into the air, which is a cause of climate change.