PLUG LOADS

Students explore ways to save energy at school by investigating electricity consumption of electrical devices and determining ways to reduce that consumption.

EFFICIENCY CONSERVATION

GRADE LEVEL

Intermediate/Secondary

SUBJECT AREAS

Science
Social Studies
Math
Language Arts
Technology

NEED 2007
Putting Energy into Education

NEED Project PO Box 10101 Manassas, VA 20108 1-800-875-5029 www.NEED.org

Plug Loads

Overview
These activities teach students how to determine the annual energy consumption and operating cost of appliances found in the school building by using a Microsoft Excel spreadsheet. Students will be able to see how energy-saving actions can impact the energy consumption of their school. While using the spreadsheet, students will also be able to calculate the amount of carbon dioxide (CO_2) produced by the generation of electricity to power each appliance. In addition, the activities teach the students about the electricity consumed even when certain appliances are turned off and how these “phantom loads” affect school energy bills and CO_2 emissions.

Background
Plug Loads is designed to complement the National Energy Education Development’s (NEED) existing Energy Management curricula, *Monitoring and Mentoring* and *Learning and Conserving*. These units guide students and teachers through a comprehensive study of how energy is used at school and home. *Plug Loads* provides an additional component to the students’ energy assessment of the school building, which is the culminating activity of NEED’s Energy Management lessons. In *Plug Loads*, students will gather data on electrical appliances in their building and utilize a spreadsheet to calculate their energy consumption and cost over time. Through this study, students will gain a greater understanding of how plug loads affect the overall energy consumption of a building and how using plug loads efficiently can lower energy costs and improve environmental quality.

What are Plug Loads?
Plug loads are electrical devices or appliances that draw power through an electric outlet. Schools typically have 120/208-volt electrical systems with many different loads. A **load** is any device that is powered by an electrical system and requires electricity to do work. Look around any classroom and see the many appliances and devices that are turned ON. Anything that has an ON/OFF switch can be a load and managing the use of these loads can help save electricity and money. A quick survey of the typical classroom and school building reveals many kinds of plug loads, such as:

- coffee makers
- computers/monitors
- fans
- desk and table lamps
- microwaves
- refrigerators
- televisions
- VCR’s
- window air conditioners
- vending machines
- printers and scanners
- fax machines
- copiers
- fish tanks
- overhead projectors
- ranges and stoves
- vocational equipment
- refrigerated drinking fountains
- clocks

Many of these devices are important to the learning environment. In addition, there are appliances that teachers and school staff bring from home that are not related to teaching, but are routine products found in any office. A survey of all plug loads in the school will help students, teachers, and school staff find ways to reduce electricity use and save money.

Once students, teachers, and staff are educated about the impacts of energy consumption, they are often willing to reduce their use of these devices. By simply monitoring daily use of plug loads, students and staff can lower the school’s utility bills, saving the school system money. This could free up additional funding for educational materials such as textbooks, school supplies and other equipment.

How Much Electricity Do Plug Loads Use?
NYSERDA estimates that up to 20 percent of the total electricity consumed by a school is from plug loads. Managing the use of such equipment can greatly reduce a school's electricity consumption.

Using the Plug Load Spreadsheet
To estimate how much electricity is consumed by plug loads in your school, you can use the Plug Load Spreadsheet. The spreadsheet is a tool that helps students quantify the relationship between plug loads and energy usage. This analysis of the Plug Load Spreadsheet can be integrated with data gathered using NEED's *Monitoring and Mentoring*, *Learning and Conserving*, or *Energy Survey* activities to give students a better understanding of energy consumption, resulting in real opportunities for reducing energy use and lowering the school's utility bill.

The Plug Load Spreadsheet was designed to simulate real world computer programs used by professional energy analysts. The students' exposure to gathering and analyzing electrical use data demonstrates the importance of energy management and builds and essential foundation needed for entering this growing career field.

Utility companies charge their customers based on the kilowatt-hours (kWh) of electricity they use each month. The first worksheet (Plug Load) takes data entered by students and calculates the kWh used by each appliance per month and per year. The cost is calculated using the national ***average electricity rate for commercial customers***. This is the rate paid by schools. This information should be available from your business office or utility company. The worksheet also calculates the CO_2 emissions produced to provide the electricity to run each appliance. This value is calculated using the ***average for CO_2 emitted per kWh of electricity generated***. The worksheet comes pre-loaded with the national average on the first active row of the worksheet.

School Plug Load Model

Average Electricity Cost = $0.081 per kWh   Average CO_2 Emitted per kWh = 0.77 lbs.

Electrical Appliance	Quantity in Use[1]	Typical Use Hours/Day	Wattage	Cycle Time[2]	Monthly kWh	Months/ Year In Use	Yearly kWh	Annual Cost per Unit	Total Annual Cost	Annual CO_2 Emissions (lbs)
Coffee Maker	25	3	900	33%	446	9	4,010	$21.17	$529	3,087
Computer/Monitor	182	7	125	100%	3,185	9	28,665	$20.79	$3,784	22,072
Fan	10	3	115	100%	69	9	621	$8.20	$82	478
Desk Lamp	30	5	75	100%	225	9	2,025	$8.91	$267	1,559
Microwave	15	0.5	1,000	100%	150	9	1,350	$11.88	$178	1,040
Tabletop Fridge (<2.5 cu.ft.)	5	24	100	33%	120	9	1,083	$28.60	$143	834
Small Fridge (2.5 - 6.4 cu.ft.)	20	24	125	33%	602	9	5,417	$35.75	$715	4,171
Television	25	1	80	100%	40	9	360	$1.90	$48	277
VCR	25	1	40	100%	20	9	180	$0.95	$24	139
Space Heater	20	7	1,500	20%	840	4	3,360	$22.18	$444	2,587
Window AC (9,000 Btu/hr)	3	8	1,000	50%	240	4	960	$42.24	$127	739
Window AC (12,000 Btu/hr)	3	8	1,300	50%	312	4	1,248	$54.91	$165	961
Cold Drink Vending Machine	6	24	800	50%	1,751	12	21,012	$462.27	$2,774	16,180
Other?										
TOTAL					8,000		70,292		$9,279	54,125

1. Quantities shown are for a typical 25-classroom, 100,000 square foot K-12 school.
2. Amount of time the appliance actually runs (ex., a coffee maker is only on about 33% of the time).
3. If necessary, change the values in the gray cells for devices you are analyzing.

Columns 1-5 and Column 7

Data can be entered into Columns 1-5 and Column 7. Columns 6, and Columns 8-11 all contain formulas and perform calculations based on the data entered in Columns 1-5 and 7. The worksheet is pre-loaded with values for Columns 1-5 and 7. The cells in Columns 1-5 and 7 are yellow, indicating cells that can be filled in with building-specific data. The best way to obtain values for Column 4 is by using a plug-in watt meter, which is included in NEED's Energy Management Kits, *Monitoring and Mentoring* and *Learning and Conserving*. Below is a description of data in each column:

Column 1: Lists appliances commonly found in school buildings.

Column 2: Gives typical quantities of these appliances found in schools.

Column 3: Gives typical usage in hours/day.

Column 4: Gives typical wattages of appliances. If students meter the appliances directly or determine the wattage from appliance nameplates (see *Monitoring and Mentoring* or *Learning and Conserving* sections on nameplate data), their data should be entered in this column.

Column 5: This column gives the amount of time these appliances are typically running when turned on. Some appliances, such as refrigerators, are always "on" when they are plugged in. However, they are controlled by thermostats so that the units only run when the temperature inside rises above a pre-set point. The percentage listed in this column is the percentage of time the appliance is typically running.

Column 7: Gives the number of months/year the equipment is operated. Nine months is the default value for schools, a value that can be changed if the school is in use for longer periods.

Each of these columns contains typical values. The actual appliances, quantities, hours of use, run time and cycle time can vary widely. The more data your students gather and enter into these first five columns, the more accurate the assessment you will have of the actual energy use in the building.

When determining values for Columns 3 and 7, it may be necessary to interview school personnel. For instance, asking a school secretary may be the best way to determine the hours of operation for a copier in the main office. The interview is an important part of any energy analysis because there is always information that is available no other way. The interview provides necessary data and incorporates a language arts element into the student energy analysis.

Columns 6 and Columns 8-11

Columns 6 and 8-11 contain pre-set values, which are exact formulas and should not be modified.

Column 6: Determines the monthly kilowatt-hour (kWh) usage by multiplying the number of appliances by the appliance wattage and the hours of operation per day, then multiplying that figure by the percentage of time the appliance is actually running when it is turned on. Finally, this formula converts the watts to kilowatts by dividing by 1,000, then multiplies the product by the number of days per month the equipment is operated (assumed to be 20 on average for most appliances and 30.4 for refrigerators and freezers).

Column 8: Multiplies the kilowatt-hours per month by the number of months to yield the kWh per year consumed by the appliances.

Column 9: Multiplies the kWh/year by the average electricity cost and then divides by the number of pieces of equipment to show the yearly cost of operating each piece of equipment.

Column 10: This column multiplies the kWh/year by the average electricity cost to yield the yearly operating cost of all pieces of equipment in this category.

Column 11: This column multiplies the kWh/year by the average amount of CO_2 (in pounds) produced by generating one kWh of electricity.

Often, there is more than one kind of appliance within a category of equipment. For instance, the school's computers could include older machines with CRT (cathode ray tube) monitors and newer ones with LCD (liquid crystal display) monitors. In such cases, each of these kinds of computers should be treated as separate pieces of equipment and have their own rows on the worksheet. Similarly, there may be categories of equipment in which some pieces have longer run times or are used year-round as opposed to nine months. Each of these run-times should also be considered as distinct pieces of equipment.

Finally, some pieces of equipment (such as computers and copiers) often spend much of their time in low power or sleep modes. In many cases, appliances also consume power when turned off (see Phantom Load section below). An advanced analysis would take this into account, as well. As with the cases mentioned above, it is necessary to use a separate row for the machine in sleep mode, with the estimated amount of hours the machine spends in that mode.

Phantom Electrical Loads

The VCR in a classroom has been flashing the time "12:00 a.m." since it was installed four years ago. The only time it has not been flashing is when a power outage occurred last winter. This is a prime example of an electronic device in today's classroom that consumes energy when the switch indicates it is off. The cost for this flashing for four years could add up to more than $10. With hundreds of these devices in a district, that can amount to a significant energy cost. This consumption of electrical energy is classified as a Phantom Load. Phantom loads are also known as Standby Power or Leaking Electricity.

Phantom loads exist in many electronic or electrical devices found in schools. Equipment with electronic clocks or timers, with remote controls, portable equipment, and office equipment with wall cubes (small box-shaped plugs that plug into AC outlets to power appliances) all have phantom loads. This equipment can consume from three to 20 watts when turned off. The Department of Energy's *Federal Energy Management Program* (FEMP) has determined the average phantom loads of many devices. On the next page is a diagram of examples of these values. Note that as technology changes, these values are being reduced and it is estimated that with new technology, as much as 75 percent of this phantom load can be reduced.

Calculating Phantom Load

To find the phantom load for an appliance, you must know how many hours per day the appliance is turned off and what the phantom load is. Below is an example for a TV in a school building:

Appliance: TV **Phantom Load: 5.5 watts** **Hours per day turned off: 22**

The total energy used during the year would be 5.5 watts x 22 hours/day x 365 days/year = 44,165 watt hours or 44 kWh. At the average commercial rate of $.081/kWh, the cost would be $3.56. (Note: A home TV's phantom load cost would be higher, due to an average residential rate of $.09/kWh.)

Of course, the usage would vary depending on the day. To get a more accurate figure, you would have to take into account the number of days when the TV is not used at all (summer vacation, weekends, holidays, etc.) where the phantom load would be drawn for 24 hours instead of 22. Taking these factors into account, the standby usage and cost would be higher. Remember, this is just for one TV. In a large school district, there could be a hundred or more TVs. To get an accurate measure of how much TV phantom load consumption there is district-wide, you would multiply the number of TVs by the average usage.

To reduce this energy consumption, unplug the TV when not in use. Consider this suggestion for other electronic devices that may not need to be continuously plugged in for educational value. On the next page is a chart showing the following:

- Average standby power (phantom load) consumption of appliances (from research conducted in 1999 by Lawrence Berkeley National Lab).
- Federal Energy Management Program (FEMP) Guidelines for standby power (phantom load) usage: These guidelines are used by federal agencies when purchasing new equipment.
- ENERGY STAR® requirements for standby (phantom Load) power consumption.

Standby Power (Phantom Load) of Electrical Devices

Electrical Device	Average*	FEMP Guidelines**	ENERGY STAR
TV	5	1	1
VCR	6	2	1
TV/VCR Combo	7.6	3	1
Portable Stereo	2.2	1	1
Compact Audio System	9.7	1	1
Component Audio System	3	1	1
DVD Player	4.2	1	1
Desktop Computer	1.7	2	No guideline set
Laptop Computer	Unavailable	1	No guideline set
Computer Monitor	Unavailable	1	1
Inkjet Printer	5	1	No guideline set
Laser Printer	Unavailable	1	No guideline set
Fax Machine	1.5	2	No guideline set
Copier	1.5	1	Varies by copier speed
Microwave Oven	2.9	2	No guideline set

* Lawrence Berkeley National Lab (4/1999)

** The Federal Energy Management Program (FEMP) sets guidelines for the purchase of electrical devices by U.S. Government agencies.

Significant savings can be achieved by reducing phantom loads. But more important than the energy reduction is the educational value for students as they gain an understanding of phantom loads and what actions can be taken to manage their impact.

In addition to the recommendation above, procurement specifications for future electronic purchases should include a requirement for minimum "Standby/Phantom" Load in accordance with the FEMP recommendations. A listing of products to be used is at http://oahu.lbl.gov/cgi-bin/search_data.pl.

You can use the Phantom Load Worksheet to calculate phantom loads. This worksheet is set up exactly like the Plug Load Worksheet, but is pre-loaded with average values for standby wattages and average times spent in standby. Only enter data for the appliance for the times when it is turned off.

Conducting the Activities

Step One
Explain to students that the electricity consumed by electrical appliances is a major component of their school's energy use. Tell students that they will be studying the electrical appliances in their building to determine their total consumption, the cost of running them and the greenhouse gas emissions produced by generating the electricity to run them. They will then come up with ideas to reduce this consumption while continuing to provide a healthy, comfortable, and productive school environment. Describe the environmental effects of electricity generation and how this is related to their study of electrical appliances. Refer to the *Monitoring and Mentoring Guide* for background.

Explain to students that they will be utilizing a spreadsheet to enter their data and determine the consumption, cost, and CO_2 emission impacts of running appliances. They will then be able to propose changes to the conditions they find and see how these changes affect the consumption, costs, and environmental impacts.

Step Two
Define key terms for students such as load, plug load, and phantom load. Refer to glossary for definitions.

Step Three
Option 1: If you are incorporating this activity into the *Electric Nameplates* lesson from *Monitoring and Mentoring*, follow instructions for completing Step Two of that lesson. In addition to the information gathered during this step, students should determine how many pieces of each type of equipment there are in the building and find out how many hours/day this equipment operates. Explain that they will, in some cases, need to talk with other teachers and school staff to determine the operating hours/day of an electrical appliance.

Option 2: If you are conducting this as a stand-alone activity, first decide to what extent your students will be using the pre-loaded values in the worksheet. This will determine the data they gather. Explain to students how to fill out the Plug Load data gathering form, including instructions on data they do not need to gather due to the use of pre-loaded values. Two versions of the form are provided. The first has all of the same pre-loaded values as the worksheet. The second version is blank. As in the case above, students will need to interview school staff to establish operating hours/day. If you are utilizing on of NEED's Energy Management Kits with your students, the plug-in watt meter can be used to determine appliance wattage. Instructions on the use of this device are found in the kit.

Step Four
Once students have completed gathering data, explain the use of the worksheet, including a description of each cell. Clearly indicate to students the columns you want them to fill in (it is recommended that you color code these columns). Once students have completed the first worksheet, discuss the results as a class. Which appliances are the largest users of electricity? Which ones are the smallest? Were there any surprises?

Step Five
Ask students if they have any recommendations for increasing efficiency or decreasing energy consumption. Discuss their ideas and add some of your own. Introduce the Plug Load Savings Worksheet. Explain that the values they see initially are automatically fed into the worksheet from the worksheet they just completed. They can change the values in Columns 2-4 based on actions they recommend. The recommended actions should be described in the last column on the sheet labeled, *Action Taken to Achieve Savings*. Discuss the results with the students. What actions would make the most difference? Which would be the easiest or most difficult to implement? If the recommendations are related to changing behaviors, how will they promote the change?

Step Six
Discuss phantom load with students, explaining that the electrical consumption of appliances that are plugged in, but powered off, can be significant. Introduce the Phantom Load Worksheet and explain that it works exactly like the Plug Load Worksheet they just completed; the main difference is that in Column 3, instead of entering *typical use*, *typical hours off* is entered. Wattages are pre-loaded, or students can determine phantom loads by using the watt meter as they did in Step 3. A Phantom Load Savings Worksheet is included in which students can determine the savings from unplugging appliances that are powered off.

Step Seven
Evaluate student performance by reviewing the completed worksheets.

Step Eight
Explain to students that through enacting awareness campaigns, they can significantly decrease energy use in their schools. Guide them through an interactive process of drafting an implementation plan for changing the energy use profile of their school, or even their entire school district. The plan should be tiered and built upon easily accomplishable steps to success.

Assist the students in translating the knowledge they've gained into school-wide or community-wide awareness campaigns. Choosing energy saving opportunities that apply to both the students' school and their homes will create rich opportunities for classroom and home discussion, and increase the level of personal involvement.

For example, during one academic quarter, students might investigate the savings available from choosing energy efficient computers and using the energy saving features on computers. A good resource for this is the EPA's (Environmental Protection Agency) ENERGY STAR® website, where students can access free software to calculate the savings potential of computer-related energy saving behaviors. Go to www.energystar.gov and type in 'power management' at the search prompt.

During another quarter, students might research the savings available by replacing older refrigerators and freezers with new, more energy efficient models. They might then present that information to key decision-makers in the school/district, as well as at home. On average, new refrigerators typically use about a third of the electricity that older models do. Many schools-–and homes, for that matter—have refrigerators and freezers that are nearly empty much of the time. Consolidating to a few newer refrigerators would add up to significant savings.

Other potentially lucrative energy saving actions for the students to investigate and implement might include replacing incandescent bulbs with compact fluorescent bulbs (a 75 percent savings).

Extension Activities

Introduce students to the concept of payback period—the amount of time it takes for an investment to pay for itself through the energy it saves. Provide students with the cost of various energy saving actions, such as replacing an incandescent lightbulb with a compact fluorescent in a desk lamp. Then introduce the formula for determining simple payback:

Payback (PB)=Cost/Annual Savings

Tell students to determine the payback period for various energy saving actions they proposed on their Plug Load Savings Worksheets.

Activity 1: Refrigerator Replacement

Other than heating hot water with an electric heater, refrigeration is generally the single largest constant contributor to plug load in residential buildings. It is often a large factor in many school buildings, as well. The following exercises will provide students with excellent practice in energy-conscious consumer decision-making.

EXAMPLE: Students at a junior high school identified a circa-1984 refrigerator with poor seals in a teacher break room, and marked it down as a good candidate for replacement. They attached a plug-in watt meter to the old refrigerator for 24 hours and found that it used 4.2 kWh of energy per day, or 1,533 kWh per year. While metering, the students noticed that the refrigerator and freezer compartments were only about three-fourths full, and queried several teachers in order to determine if this was a constant situation, or an anomaly. They determined that it would be safe to downsize the replacement refrigerator by 2 cubic feet.

The students shopped online for a new refrigerator, and quickly found many ENERGY STAR® rated top-freezer-style models. They settled upon a sturdy, no-frills model that their school could purchase tax-free for $590. The product specifications showed that the model consumes approximately 407 kWh per year.

Next, they determined the annual energy savings from replacing the old refrigerator with the new one:

1,533 kWh/yr (old) – 407 kWh/yr (new) = 1,126 kWh/yr in saved electricity

To determine the cost savings, they multiplied the savings by electricity rate:

1,126 kWh/yr x $0.081 avg. commercial rate = $91.21 savings per year

Finally, they divided the purchase price of the new refrigerator by the annual cost savings to determine the payback period:

$590 purchase price / $148.63 annual savings = 6.47 year payback

Since the average life of a refrigerator is 15 years and the payback period for replacing the refrigerator was a little over five years, the school's administration elected to request that their district purchase the model recommended by the students.

Activity 2: Lightbulb Replacement

Lighting is a significant cost to schools and homes. Reducing the cost of lighting can impact energy costs.

EXAMPLE: A 5th grade student audit team at an elementary school found that twelve of the school's teachers and staff had desk lamps either on their desks or at their computer stations. The team observed and logged run-time for the lamps for a week, and found that almost all were left on for the entire workday, or from approximately 8 a.m. to 4 p.m. They discovered that all of the bulbs in the twelve lamps were 60-watt incandescents.

The students researched the equivalent wattages for compact fluorescent bulbs and incandescent bulbs, and found that a 15-watt CFL provides the same light level as a 60-watt incandescent bulb. They then looked through ad sections of the local newspaper, and discovered that a nearby home store was offering a package of three ENERGY STAR® rated compact fluorescent bulbs for just $10. In order to replace the 12 bulbs, the students determined they would need four packages of three bulbs each. With guidance, the students set about calculating the annual plug load cost of the old incandescent bulbs. First, they determined that there were 180 school days in their district's school year, so they multiplied 180 days by 8 hours a day, and got 1,440 hours of on-time per lamp. Then they multiplied 1,440 by twelve, yielding a total of 17,280 hours of 60-watt bulb use.

1,440 hours x 12 lamps = 17,280 total hours

The fifth-graders continued their calculations by determining how many watts were used annually by the old incandescent bulbs:

17,280 hours x 60 watts/hr = 1,036,800 watt hours

Arriving at that large a number of watts astounded the students. They had been taught that a kilowatt-hour equals 1,000 watts of energy, so the students divided their grand sum of 1,036,800 watts per year by 1,000 and got 1,036.8 kWh.

1,036,800 watts / 1,000 watts/kW = 1,036.8 kWh

They then multiplied that number by $0.132, New York State's average cost for commercial electricity:

1,036.8 kWh x $.081/kWh = $83.98

For their final factor in determining payback, they figured the total cost of operating the 15-watt CFLs for a year. First, they determined how much energy the CFLs would consume during the year in kWh:

17,280 hours x 15 watts/hr = 259,200 watt hours /1,000 watts/kW = 259.2 kWh

Next they multiplied the consumption by the commercial electric rate:

259.2 kWh x $0.132/kWh = $21.00

The total cost for four CFLs is:

4 CLFs x $5 = $20

To determine the savings, they subtracted the cost of operating the CFLs from the cost of operating the incandescents:

$83.98 (incandescent bulb consumption) – $21.00 (CFL consumption) = $62.98

Finally, they divided the cost of the CFLs by the annual savings to determine the payback period:

$20 / $62.98 = a payback period of .317, or less than a third of a year.

Impressed, the students went a step further to determine the life-cycle savings of making the bulb conversion. They divided the average 10,000-hour life of a CFL by 1,440 and determined that the new bulbs would last seven years. They deducted the payback period, and calculated that 6.41 years of savings would amount to $403.70. Armed with their facts and figures, the 5th grade student audit team had no problem whatsoever convincing their principal to purchase $20 worth of compact fluorescent lightbulbs for the teachers and staff to use in their personal desk lamps!

Glossary

120/208 Volt Service: These are the common voltages used for wall outlets in North America.

Energy Analyst: A professional who analyzes the energy use of a building and recommends building improvements or behavior changes that reduce energy consumption.

ENERGY STAR®: A federal government-backed program helping businesses and individuals protect the environment through superior energy efficiency.

Federal Energy Management Program (FEMP): A program of the U.S. Department of Energy that works to reduce the cost and environmental impact of the Federal government by advancing energy efficiency and water conservation, promoting the use of distributed and renewable energy, and improving utility management decisions at Federal sites.

Watt meter: A device that measures the power consumed by an electrical appliance.

Kilowatt-hour (kWh): A unit of energy equal to the work done by a power of 1000 watts operating for one hour. Utility companies charge their customers based on how many kilowatt-hours they consume each month.

Load: Any device that draws power from the electrical system and requires electricity to do work.

Outlet: A wall-mounted receptacle that is connected to a power supply and equipped with a socket for a plug.

Payback period: The amount of time that it takes for the annual savings to equal the initial investment.

Phantom loads: The electricity draw created by devices that consume electrical energy even when powered off.

Plug load: The electricity draw created by any electrical appliance that plugs into an electrical wall outlet.

Wall cube: A cube-shaped transformer that plugs into the wall outlet to power a lower voltage appliance. This device changes 120 V AC power to low voltage DC power to provide power to many of our electronic devices in schools.

PLUGLOADS
Evaluation Form

Grade Level: ___________   Number of Students: __________

	Question		
1.	Did you conduct the entire unit?	Yes	No
2.	Were the instructions clear and easy to follow?	Yes	No
3.	Did the activities meet your academic objectives?	Yes	No
4.	Were the activities age appropriate?	Yes	No
5.	Were the allotted times sufficient to conduct the unit?	Yes	No
6.	Was the unit easy to use?	Yes	No
7.	Was the preparation required acceptable for the activities?	Yes	No
8.	Were the students interested and motivated?	Yes	No
9.	Was the energy knowledge content age appropriate?	Yes	No
10.	Would you use the unit again?	Yes	No

How would you rate the unit overall (excellent, good, fair, poor)?

How would your students rate the unit overall (excellent, good, fair, poor)?

What would make the unit more useful to you?

Other Comments:

Please fax or mail to:
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Manassas, VA 20108

FAX: 1-800-847-1820

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Narragansett Electric–A National Grid Company
New Jersey Department of Environmental Protection
NASA Educator Resource Center–WV
National Alternative Fuels Training Center–West Virginia University
National Association of State Energy Officials
National Association of State Universities and Land Grant Colleges
National Biodiesel Board
National Fuel
National Hydrogen Association
National Hydropower Association
National Ocean Industries Association
New Jersey Department of Environmental Protection
New York Power Authority
North Carolina Department of Administration–State Energy Office
Northern Indiana Public Service Company–NIPSCO
Nebraska Public Power District
New Mexico Oil Corporation
New Mexico Landman's Association
New York State Energy Research and Development Authority
Noble Energy
Nuclear Energy Institute
Offshore Energy Center/Ocean Star/OEC Society
Offshore Technology Conference
Ohio Energy Project
Oil & Gas Rental Services
Pacific Gas and Electric Company
Petroleum Equipment Suppliers Association
Poudre School District–CO
Puerto Rico Energy Affairs Administration
RSA Engineering
Renewable Fuels Association
Roanoke Gas
Robert Gorham
Roswell Desk and Derrick Club
Roswell Geological Society
Rhode Island State Energy Office
Saudi Aramco
Schlumberger
SchoolDude.com
Sentech, Inc.
Shell Exploration and Production
Snohomish County Public Utility District–WA
Society of Petroleum Engineers
Southwest Gas
Spring Branch Independent School District–TX
Tennessee Department of Economic and Community Development
Texas Education Service Center–Region III
Toyota
TransOptions, Inc.
University of Nevada–Las Vegas
United Illuminating Company
Urban Options–MI
U.S. Environmental Protection Agency
U.S. Department of Agriculture–Biodiesel Education Program
U.S. Department of Energy
U.S. Department of Energy–Hydrogen, Fuel Cells and Infrastructure Technologies
U.S. Fuel Cell Council
Vectren Energy Delivery
Virgin Islands Energy Office
Virginia Department of Mines, Minerals and Energy
Virginia Department of Education
Virginia General Assembly
Wake County Public Schools–NC
Western Kentucky Science Alliance
W. Plack Carr Company
Xcel Energy
Yates Petroleum