MISSION POSSIBLE
ENERGY TRADE-OFFS

Students work in groups to develop an energy plan to provide more electricity for a growing country.

ENERGY SOURCES

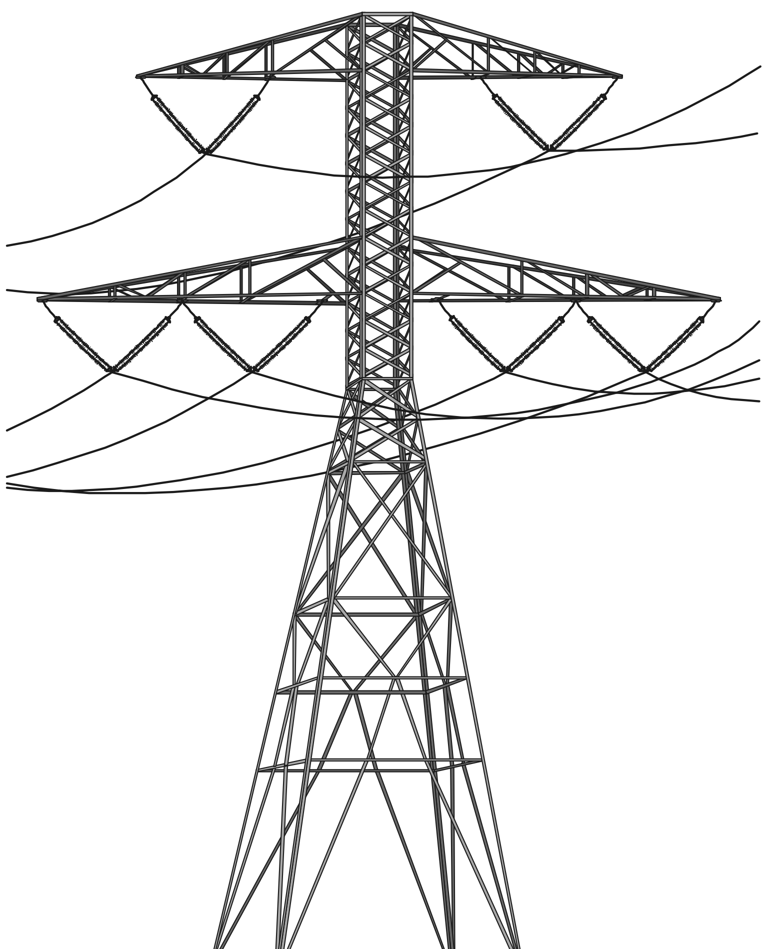
ELECTRICITY

GRADE LEVEL

7–12

SUBJECT AREAS

Science
Social Studies
Math
Language Arts
Technology



NEED

2009-2010

Putting Energy into Education

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

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Teacher Advisory Board Vision Statement

NEED Mission Statement

The mission of the 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.

In support of NEED, the national Teacher Advisory Board (TAB) is dedicated to developing and promoting standards-based energy curriculum and training.

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Data on Cost of Electricity is from the Department of Energy's Energy Information Administration, www.eia.doe.gov.

RECOMMENDED or SAMPLE ENVIRONMENTAL IMPACT UNITS

	FACILITIES	ENVIRO IMPACT (EU)
2	Existing Modern Plants	800 EU
3	Modernized Coal Plants	250 EU
4	New Coal Plants	50 EU each
5	Wind Farms	0 EU
6	Hydropower Dams	10 EU each
7	Nuclear Plants	20 EU each
8	Waste-to-Energy Plants	2 EU each
9	Natural Gas Plants	30 EU each
10	Geothermal Plants	10 EU each
11	Solar Plants	0 EU

NEED
Putting Energy into Education

Correlations to National Science Standards

(Bolded standards are emphasized in the unit.)

INTERMEDIATE (GRADES 4–8) STANDARD E: SCIENCE AND TECHNOLOGY

1. Abilities of Technological Design

- **a. Identify appropriate problems for technological design.**
- **b. Design a solution or product.**
- **c. Implement a proposed design.**
- **d. Evaluate completed technological designs or products.**
- **e. Communicate the process of technological design.**

2. Understandings about Science and Technology

- **c. Technological solutions are temporary and have side effects. Technologies cost, carry risks, and have benefits.**
- **f. Perfectly designed solutions do not exist. All technological solutions have trade-offs, such as safety, cost, efficiency, and appearance. Risk is part of living in a highly technological world. Reducing risk often results in new technology.**

INTERMEDIATE–F: SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES

3. Natural Hazards

- **b. Human activities can induce hazards through resource acquisition, urban growth, land-use decisions, and waste disposal.**

4. Risks and Benefits

- **c. Students can use a systematic approach to thinking critically about risks and benefits.**
- **d. Important personal and social decisions are made based on perceptions of benefits and risks.**

5. Science and Technology in Society

- a. Science influences society through its knowledge and world view. The effect of science on society is neither entirely beneficial nor entirely detrimental.
- b. Societal challenges often inspire questions for scientific research, and societal priorities often influence research priorities.
- c. Technology influences society through its products and processes. Technological changes are often accompanied by social, political, and economic changes that can be beneficial or detrimental to individuals and to society. Social needs, attitudes, and values influence the direction of technological development.
- e. Science cannot answer all questions and technology cannot solve all human problems or meet all human needs. Students should appreciate what science and technology can reasonably contribute to society and what they cannot do. For example, new technologies often will decrease some risks and increase others.

SECONDARY (GRADES 9–12) STANDARD E: SCIENCE AND TECHNOLOGY

1. Abilities of Technological Design

- **a. Identify a problem or design an opportunity.**
- **b. Propose designs and choose between alternative solutions.**
- **c. Implement a proposed solution.**
- **d. Evaluate the solution and its consequences.**
- **e. Communicate the problem, process, and solution.**

SECONDARY–F: SCIENCE IN PERSONAL AND SOCIAL PERSPECTIVES

3. Natural Resources

- **a. Human populations use resources in the environment to maintain and improve their existence.**
- b. The earth does not have infinite resources; increasing human consumption places severe stress on the natural processes that renew some resources, and depletes those resources that cannot be renewed.
- c. Humans use many natural systems as resources. Natural systems have the capacity to reuse waste but that capacity is limited. Natural systems can change to an extent that exceeds the limits of organisms to adapt naturally or humans to adapt technologically.

4. Environmental Quality

- **c. Many factors influence environmental quality. Factors that students might investigate include population growth, resource use, population distribution, overconsumption, the capacity of technology to solve problems, poverty, the role of economic, political, and religious views, and different ways humans view the earth.**

5. Natural and Human-induced Hazards

- b. Human activities can enhance potential for hazards. Acquisition of resources, urban growth, and waste disposal can accelerate rates of natural change.
- **d. Natural and human-induced hazards present the need for humans to assess potential danger and risk. Many changes in the environment designed by humans bring benefits to society, as well as cause risks. Students should understand the costs and trade-offs of various hazards—ranging from those with minor risk to a few people to major catastrophes with major risk to many people.**

6. Science and Technology in Local, National, and Global Challenges

- b. Understanding basic concepts and principles of science and technology should precede active debate about the economics, policies, politics, and ethics of various science and technology related challenges. However, understanding science alone will not resolve local, national, and global challenges.

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Teacher Guide

STUDENTS RECOGNIZE AND EVALUATE THE ECONOMIC, ENVIRONMENTAL, AND SOCIETAL TRADE-OFFS OF THE MAJOR ENERGY SOURCES USED TO GENERATE ELECTRICITY.

BACKGROUND

Mission Possible: Energy Trade-offs is a cooperative learning activity in which intermediate and secondary students evaluate the advantages and disadvantages of the energy sources used to generate electricity by developing energy plans for a fictitious country and presenting the plans to the class. Several options with different levels of difficulty are provided for the activity. The activity includes a limited number of variables and is not intended to reflect the realities of the global or national economies.

CONCEPTS

- All energy sources have economic, environmental, and societal advantages and disadvantages.
- Economic and environmental impacts are determining factors in the energy sources we use to produce electricity.
- Societal needs, personal beliefs, and changes to the quality of life are important considerations in determining the energy sources we use.
- No one energy source can meet the needs of society today; a variety of energy sources is needed.
- Some energy sources cannot be counted on to produce consistent amounts of electricity 24-hours a day or in all seasons and weather conditions (wind, solar, hydorpower).

TIME

- Five to seven class periods, plus homework.

SKILL REINFORCEMENT

- Critical thinking
- Math—number manipulation—positive & negative integers
- Cooperative learning
- Comparison and contrast
- Negotiation and compromise
- Evaluation of multiple factors
- Presentation and persuasion

MATERIALS & PREPARATION

- Familiarize yourself with the **Teacher** and **Student Guides**. Experiment with several options to decide which option you will use. It is recommended that you complete the activity yourself before assigning it to your students.
- Make one copy of the **Student Guide, Energy Plan,** and **Facts about the Energy Sources** for each student, plus one extra copy of the **Energy Plan** for each group.
- Make a transparency of the **Sample Energy Plan** for use with younger students.
- Make available NEED's **Intermediate** or **Secondary Infobooks** as resources on the energy sources.
- Make available computers with spreadsheet capabilities. A sample spreadsheet is available on the NEED website at **www.NEED.org** under the Educator/Curriculum tabs.

PROCEDURE

OPTION 1 (SIMPLE): STUDENTS USE SAMPLE ENVIRONMENTAL IMPACTS AND A PRE-DESIGNED SPREADSHEET TO DEVELOP ENERGY PLANS

Individual computers with Excel software and spreadsheet from NEED website pre-loaded.

DAY ONE

- Provide each student with a copy of the **Student Guide** and **Facts about the Energy Sources** and explain the activity to the class. Make sure the students understand that this activity is an exercise to explore trade-offs and the need for multiple energy sources. The activity includes a limited number of variables and is not intended to reflect the realities of the global or national economies. In addition, explain that some energy sources, such as solar and wind, do not produce consistent amounts of electricity all the time, so their total capacity must be increased when choosing these sources. Note also that several energy sources—wind, hydropower, and waste-to-energy—include a limited number of facilities that can be built because of geographical or fuel limitations.

  Make sure that the students understand that when the old coal plants are modernized, the total environmental impact does not change while total capacity increases, so that the environmental impact per megawatt is reduced with the addition of pollution control devices.
- Review the **Student Guide** and answer any questions about the activity. Give the students the sample environmental impact figures (from page 3) and have them write them on the blank lines in their **Student Guides**. Discuss whether students agree or disagree with the sample figures.
- Provide each student with an **Energy Plan Form**. Explain that the students will use a pre-designed spreadsheet to formulate their individual energy plans. Use a transparency of the **Sample Energy Plan** to explain the assignment to the class.
- Instruct each student to formulate an individual energy plan, using the **Mission Possible Spreadsheet** that is downloadable from the NEED website.

DAY TWO

- Divide the class into groups of three–to–five students. Provide a copy of the **Energy Plan Form** to each group. Explain that each group will use their individual plans to form a consensus and develop a group energy plan to present to the class.

DAYS THREE & FOUR

- Have each group present their **Energy Plan** to the class. The time for this step will depend upon how much discussion you allow with each presentation. You may wish to have the class, acting as a Citizens' Council, vote on each plan after it is presented.

DAY FIVE: EVALUATION & ASSESSMENT

- Evaluate student performance using class participation, individual plans, group participation, and presentations.
- Design or select two energy plans and have the students evaluate them and write an essay explaining which one they think is the better one.
- Complete the **Evaluation Form** on page 15 with the class and mail or fax to NEED Headquarters.

OPTION 2 (MODERATE & TECHNOLOGY INTENSIVE): STUDENTS DETERMINE ENVIRONMENTAL IMPACTS AND CREATE SPREADSHEETS WITH FORMULAS PROVIDED TO DEVELOP ENERGY PLANS

Individual computers with Excel software required. Instruction necessary in basic spreadsheet development.

- Provide each student with a copy of the **Student Guide** and **Facts about the Energy Sources** and explain the activity to the class. Make sure the students understand that this activity is an exercise to explore trade-offs and the need for multiple energy sources. The activity includes a limited number of variables and is not intended to reflect the realities of the global or national economies. In addition, explain that some energy sources, such as solar and wind, do not produce consistent amounts of electricity all the time, so their total capacity must be increased when choosing these sources.
- Review the **Student Guide** and answer any questions about the activity.

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- Sample Environmental Impact figures have been provided on page 3. The importance of environmental impact is subjective and difficult to quantify, It is suggested that you take a class period to allow the students, as a class, to determine the **Environmental Impact** figures for the activity. Provide the class with the sample figures as a starting point and discuss the advantages and disadvantages of each energy source. If students have difficullty agreeing upon an impact figure, determine the class average for use in the activity. Be aware that if students place too much emphasis on environmental impact, without consideration of economic impact, they will not be able to develop a plan with the funds available.
- After the class has determined an **Environmental Impact** figure for each energy source, have the students record the figures on the blank lines in their **Student Guides**.

  NOTE: If you do not give the students the numbers from the sample plan as reference figures, point out that the old coal-fired plants produce 50 EU (Environmental Impact Units) per plant; when the five plants are modernized, each plant's total environmental impact remains the same, but its capacity is increased by 10 MW, resulting in reduced environmental impact per MW.

DAYS TWO & THREE

- Provide each student with an **Energy Plan Form**. Explain that the students will create a spreadsheet to formulate their individual energy plans. Use a transparency of the **Sample Energy Plan** to explain the assignment to the class.
- Instruct each student to design a spreadsheet of the Energy Plan Form using the formulas on the next page. You can provide all or samples of the formulas, depending on the level of competency with Excel.
- When the students have created their spreadsheets, instruct them to formulate individual energy plans.

DAY FOUR

- Divide the class into groups of three–to–five students. Provide a copy of the **Energy Plan Form** to each group. Explain that each group will use their individual plans to form a consensus and develop a group energy plan to present to the class.

DAYS FIVE & SIX

- Have each group present their **Energy Plan** to the class. The time for this step will depend upon how much discussion you allow with each presentation. You may wish to have the class, acting as a Citizens' Council, vote on each plan after it is presented.

DAY SEVEN: EVALUATION & ASSESSMENT

- Evaluate student performance using class participation, individual plans, group participation, and presentations.
- Design or select two energy plans and have the students evaluate them and write an essay explaining which one they think is the better one.
- Complete the **Evaluation Form** on page 15 with the class and mail or fax to NEED Headquarters.

OPTION 3 (CHALLENGING & TECHNOLOGY-INTENSIVE): STUDENTS DETERMINE ENVIRONMENTAL IMPACTS AND CREATE THEIR OWN SPREADSHEETS

Individual computers with Excel software required. Competency required in basic spreadsheet development.

- Follow the instructions for Option 2, except that students must design their individual spreadsheets without being provided the formulas.

OPTION 4 (DIFFICULT & MATH-INTENSIVE): STUDENTS DETERMINE ENVIRONMENTAL IMPACTS AND DEVELOP INDIVIDUAL ENERGY PLANS USING CALCULATORS.

- Follow the instructions for Option 2, except that students develop their energy plans without spreadsheets.

EXTENSIONS

- Have students draw maps of Essowess and their individual plans.
- Have students research the area in which they live and write a persuasive paper explaining the type of power plant that should be built to provide added electricity.
- Have students research ways to lower electricity consumption in their community.
- Have students participate in NEED's Energy Conservation Contract activity.

MASTER SPREADSHEET WITH FORMULAS

	A	B	C	D	E	F	G
1	FACILITIES	#	ECONOMIC COST ($$)	CAPACITY MW	ENVIRO IMPACT (EU)	COST OF ELEC	TOTAL COST
2	Existing Modern Plants	20	800	800	800	0.05	=D2*F2
3	Modernize 5 Old Coal Plants	5	250	250	250	0.05	=D3*F3
4	Build New Coal Plants		=B4*40	=B4*50	=B4*50	0.05	=D4*F4
5	Build up to 5 Wind Farms		=B5*9	=B5*10	=B5*0	0.04	=D5*F5
6	Build up to 2 Hydropower Dams		=B6*110	=B6*50	=B6*10	0.01	=D6*F6
7	Build Nuclear Plants		=B7*85	=B7*100	=B7*20	0.07	=D7*F7
8	Build up to 2 Biomass Waste-to-Energy Plants		=B8*17	=B8*10	=B8*2	0.06	=D8*F8
9	Build Natural Gas Plants		=B9*50	=B9*50	=B9*30	0.06	=D9*F9
10	Build up to 3 Geothermal Plants		=B10*25	=B10*20	=B10*4	0.04	=D10*F10
11	Build Solar Plants		=B11*30	=B11*10	=B11*0	0.02	=D11*F11
	TOTALS		=SUM(C2:C11)	=SUM(D2:D11)	=SUM(E2:E11)		=SUM(G2:G11)/D12
	GOAL		1700	=1500+B5+B11	1200	0.05	

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Student Guide

YOUR MISSION

Your team has been hired by the governor of Essowess to develop a plan to expand the electricity capacity for the country. The country is growing and has begun to experience brownouts during peak demand times. Your mission is to develop a plan that will meet the electricity demand of Essowess economically, while maintaining the quality of the country's environment.

Essowess has many energy resources that can be used to produce the electricity it will need in the future. You can use any mixture of sources, and as many of each as allowed, as long as you produce the required amount of electricity, while staying within your budget and maintaining the environmental quality of the country. You must convince the governor and the citizens of the country that your plan is the best possible plan for everyone, in terms of jobs, the environment, and the cost of electricity and changes in lifestyle. If your plan costs more than is budgeted, damages the environment more than is acceptable, or raises the cost of electricity, you must win the approval of the Citizens' Council.

YOUR GOAL

	CURRENT STATUS:	YOUR GOAL:
Capacity:	**1,000 MW**	**1,500 MW**
20 Modern Plants @ 40 MW	*800 MW*	
5 Old Plants @ 40 MW	*200 MW*	
Economic Cost:	**1,000 energy bucks ($$)**	**1,700 energy bucks ($$)**
20 Modern Plants @ 40 $$	*800 $$*	
5 Old Plants @ 40 $$	*200 $$*	
Environmental Cost:	**1,050 enviro-units (EU)**	**1,200 enviro-units (EU)**
20 Modern Plants @ 40 EU	*800 EU*	
5 Old Plants @ 50 EU	*250 EU*	
Cost of Electricity:	**$0.05 kWh**	**$0.05 kWh**

YOUR OPTIONS

CURRENT FACILITIES

At the present time, 25 coal-fired plants provide Essowess with all of its electricity. Twenty of the plants have modern pollution control devices. Five of the plants are old and must be modernized because they have no pollution control devices. When the old plants are modernized, their total environmental impact remains the same, but their capacity is increased, resulting in lower environmental impact per megawatt.

TO MODERNIZE EACH OLD PLANT:	
Economic Cost (to modernize):	15 $$
Economic Cost (job gain):	–5 $$
Additional Capacity:	10 MW
Additional Environmental Impact:	0 EU
Cost of Electricity:	$0.05 kWh

OPTIONS CONTINUED

COAL-FIRED PLANTS: Coal is an abundant resource in Essowess. The country has a 150–year supply of coal at the current rate of consumption. Half of the reserves, however, are located in wilderness areas.

TO BUILD EACH PLANT (NO MAXIMUM):

Economic Cost (to build):	50 $$
Economic Cost (job gain):	–10 $$
Capacity:	50 MW
Environmental Impact:	______________ EU
Cost of Electricity:	$0.05 kWh

WIND FARMS: There are not many places on Essowess that have consistent winds. Along the eastern coastline, however, the wind blows at a rate that would run wind machines most of the year. Some residents along the coast would like to turn the area into a tourist area with resort hotels. Wind farms cannot be counted on to produce electricity 24 hours a day, every day of the year. For every wind farm you build, you must add 1 MW to your capacity goal of 1500 MW.

TO BUILD EACH WIND FARM (MAXIMUM 5–DETERMINED BY SITES WITH ACCEPTABLE WIND SPEED):

Economic Cost (to build):	10 $$
Economic Cost (job gain):	–2 $$
Economic Cost (land use loss):	1 $$
Capacity:	10 MW
Environmental Impact:	______________ EU
Cost of electricity:	$0.04 kWh

HYDROPOWER PLANTS: The powerful Aichtuwoe River flows from the Osohi Mountains through farmland and a national park to the coast of Essowess. Two hydroelectric dams could be built on the river to produce electricity. There is no other river that can be dammed to produce hydropower.

TO BUILD EACH DAM (MAXIMUM 2–DETERMINED BY ACCEPTABLE SITES ON RIVER):

Economic Cost (to build):	100 $$
Economic Cost (land use loss):	20 $$
Economic Cost (job/recreation gain):	–10 $$
Capacity:	50 MW
Environmental Impact:	______________ EU
Cost of electricity:	$0.01 kWh

NUCLEAR POWER PLANTS: Essowess has an abundance of uranium that could be mined and processed, providing jobs for many people, if there were a demand. Many people are concerned about nuclear power plants because the country has no place at present to store the spent fuel.

TO BUILD EACH PLANT (NO MAXIMUM):

Economic Cost (to build):	100 $$
Economic Cost (job gain):	–15 $$
Capacity:	100 MW
Environmental Impact:	______________ EU
Cost of electricity:	$0.07 kWh

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WASTE-TO-ENERGY PLANTS: The non-recyclable trash in Essowess is currently being landfilled. The combustible material in that trash (such as plastics, organic wastes, paper products, etc.) could be burned to produce electricity and reduce the amount of trash sent to landfills. There is enough combustible trash produced to fuel two power plants at the present time.

TO BUILD EACH PLANT (MAXIMUM 2–DETERMINED BY AMOUNT OF ACCEPTABLE TRASH):

Economic Cost (to build):	20 $$
Economic Cost (decreased disposal):	–3 $$
Capacity:	10 MW
Environmental Impact:	_______________ EU
Cost of Electricity:	$0.07 kWh

NATURAL GAS PLANTS: At present, there is no available natural gas supply on Essowess to fuel natural gas power plants. Geologists believe there are offshore deposits; however, a production and distribution system must be built. This would increase the investment cost, but also provide jobs.

TO BUILD EACH PLANT (NO MAXIMUM):

Economic Cost (to build):	80 $$
Economic Cost (job gain):	–30 $$
Capacity:	50 MW
Environmental Impact:	_______________ EU
Cost of Electricity:	$0.06 kWh

GEOTHERMAL POWER PLANTS: Several high temperature geothermal reservoirs are located in a wilderness area named for the country's founder, who is buried in a shrine near one of the reservoirs.

TO BUILD EACH PLANT (MAXIMUM 3–DETERMINED BY NUMBER OF RESERVOIRS):

Economic Cost (to build):	30 $$
Economic Cost (job gain):	–5 $$
Capacity:	20 MW
Environmental Impact:	_______________ EU
Cost of Electricity:	$0.04 kWh

SOLAR POWER PLANTS: The amount of solar radiation in all seasons and in all locations in the country makes it possible to use photovoltaic power plants to produce electricity. Solar systems, however, do not produce electricity 24 hours a day or every day of the year. For every solar plant you build, you must add 1 MW to your capacity goal of 1500 MW.

TO BUILD EACH PLANT (NO MAXIMUM):

Economic Cost (to build):	30 $$
Economic Cost (job gain):	–2 $$
Economic Cost (land use loss):	2 $$
Capacity:	10 MW
Environmental Impact:	_______________ EU
Cost of Electricity:	$0.02 kWh

FACTS ABOUT ENERGY SOURCES & POWER PLANTS

COAL-FIRED PLANTS:

- use an abundant domestic resource––coal.
- burn coal—the mining of which can damage land and pollute water if not managed well.
- emit some pollutants into the air when burned, even if advanced anti-pollution measures are installed.
- produce carbon dioxide (CO_2) when burned.
- use a nonrenewable resource as fuel.

WIND FARMS:

- require a lot of land, but the land can also be used for other purposes.
- do not produce electricity all of the time.
- sometimes make noise and may kill birds, but do not pollute the air or water.
- use an energy source that is free to harvest.
- use a renewable resource as fuel.

HYDROPOWER PLANTS:

- require that a lot of land be flooded for the reservoir, which can be used for recreational purposes.
- can damage ecological habitats.
- produce no air and minimal water pollution.
- use a renewable resource as fuel.

NUCLEAR POWER PLANTS:

- use small amounts of an economical and abundant energy resource.
- produce no air or water pollution.
- produce radioactive spent fuel that can be very dangerous and must be stored carefully at secure storage facilities.

WASTE-TO-ENERGY PLANTS:

- burn trash to produce electricity.
- reduce the need for landfill space.
- produce CO_2 and limited air pollutants when burned, and can smell bad.

NATURAL GAS PLANTS:

- are excellent for peak load plants because they can be brought on-line and shut down quickly.
- use a clean burning fossil fuel, but still emit CO_2 and some pollutants into the air.
- use a nonrenewable resource (with undetermined reserves in Essowess).

GEOTHERMAL POWER PLANTS:

- are built on the site of the geothermal reservoir.
- produce few environmental impacts.
- use a renewable resource.

SOLAR POWER PLANTS:

- cannot produce electricity all of the time.
- produce no pollution but require large land areas.
- use energy from the sun that is free to harvest.
- use a renewable resource.

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MISSION POSSIBLE ENERGY PLAN

FACILITIES	QUANTITY	ECONOMIC COST ($$)	CAPACITY MW	ENVIRO IMPACT (EU)	COST OF ELECTRICITY
Existing Modern Plants	20	800	800	800	0.05
Modernize 5 Old Coal Plants	5	200 + 50 = 250	200 + 50 = 250	250	0.05
Build New Coal Plants					
Build up to 5 Wind Farms					
Build up to 2 Hydro Dams					
Build Nuclear Plants					
Build up to 2 Waste-to-Energy Plants					
Build Natural Gas Plants					
Build up to 3 Geothermal Plants					
Build Solar Plants					
TOTALS					*
GOAL		1700	1500	1200	0.05

* To determine the average cost of electricity per kWh, use the formula below:

Sum of all sources [(capacity of source) x (cost per kWh of source)] ÷ Total Capacity of All Sources

SAMPLE ENERGY PLAN

FACILITIES	QUANTITY	ECONOMIC COST ($$)	CAPACITY (MW)	ENVIRO IMPACT (EU)	ELECTRICITY COST ($/KWH)
Existing Modern Plants	20	800	800	800	0.05
Modernize 5 Old Coal Plants	5	200 + 50 = 250	200 + 50 = 250	250	0.05
Build New Coal Plants	0	0	0	0 x 50 = 0	0.05
Build up to 5 Wind Farms	5	45	50	5 x 0 = 0	0.04
Build up to 2 Hydropower Dams	2	220	100	2 x 10 = 20	0.01
Build Nuclear Plants	1	85	100	1 x 20 = 20	0.07
Build up to 2 Waste-to-Energy Plants	2	34	20	2 x 2 = 4	0.06
Build Natural Gas Plants	2	100	100	2 x 30 = 60	0.05
Build up to 3 Geothermal Plants	3	75	60	3 x 4 = 12	0.04
Build Solar Plants	3	90	30	3 x 0 = 0	0.02
TOTALS		1699	1510	1166	* 0.05
GOAL		1700	1508	1200	0.05

* To determine the average cost of electricity per kWh, use the formula below:

Sum of all sources [(capacity of source) x (cost per kWh of source)] ÷ Total Capacity of All Sources

*Sum of all sources [(capacity of source) x (cost per kWh of source)] ÷ Total Capacity of All Sources

40.00 + 12.50 + 2.00 + 1.00 + 7.00 + 1.20 + 6.00 + 2.40 + 0.60 = 72.70

72.70 ÷ 1510 = $0.05 kWh

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MISSION POSSIBLE

Evaluation Form

State: ___________ **Grade Level:** ___________ **Number of Students:** __________

1.	Did you conduct the entire activity?	Yes	No
2.	Were the instructions clear and easy to follow?	Yes	No
3.	Did the activity meet your academic objectives?	Yes	No
4.	Was the activity age appropriate?	Yes	No
5.	Were the allotted times sufficient to conduct the activity?	Yes	No
6.	Was the activity easy to use?	Yes	No
7.	Was the preparation required acceptable for the activity?	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 activity again?	Yes	No

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

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

What would make the activity more useful to you?

Other Comments:

Please fax or mail to:

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