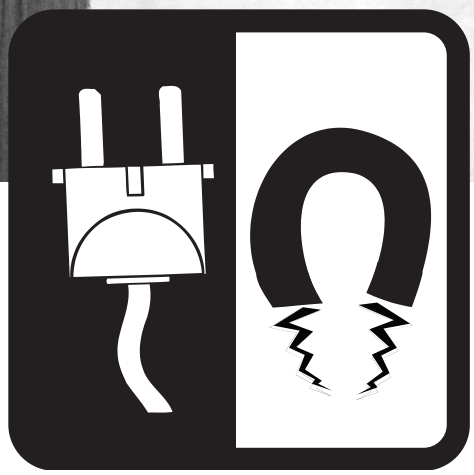
Mission Possible

Student groups are challenged to develop an energy plan to provide more electricity for a growing country. Students consider the advantages and disadvantages of the energy sources available to increase electricity generation while considering environmental quality and economic demands.



Grade Level:

Sec Secondary

Subject Areas:

- Science
- Social Studies
- Language Arts
- Technology
- Math

NEED
National Energy Education Development Project

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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.

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Teacher Advisory Board

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

Energy Data Used in NEED Materials

NEED believes in providing teachers and students with the most recently reported, available, and accurate energy data. Most statistics and data contained within this guide are derived from the U.S. Energy Information Administration. Data is compiled and updated annually where available. Where annual updates are not available, the most current, complete data year available at the time of updates is accessed and printed in NEED materials. To further research energy data, visit the EIA website at www.eia.gov.

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National Energy Education Development

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Mission Possible

Data regarding the cost of electricity is taken from the Department of Energy's Energy Information Administration, www.eia.gov.

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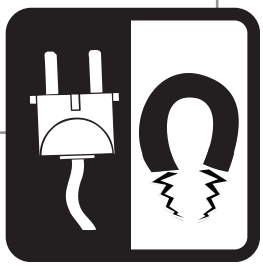


Standards Correlation Information

www.NEED.org/curriculumcorrelations

Next Generation Science Standards

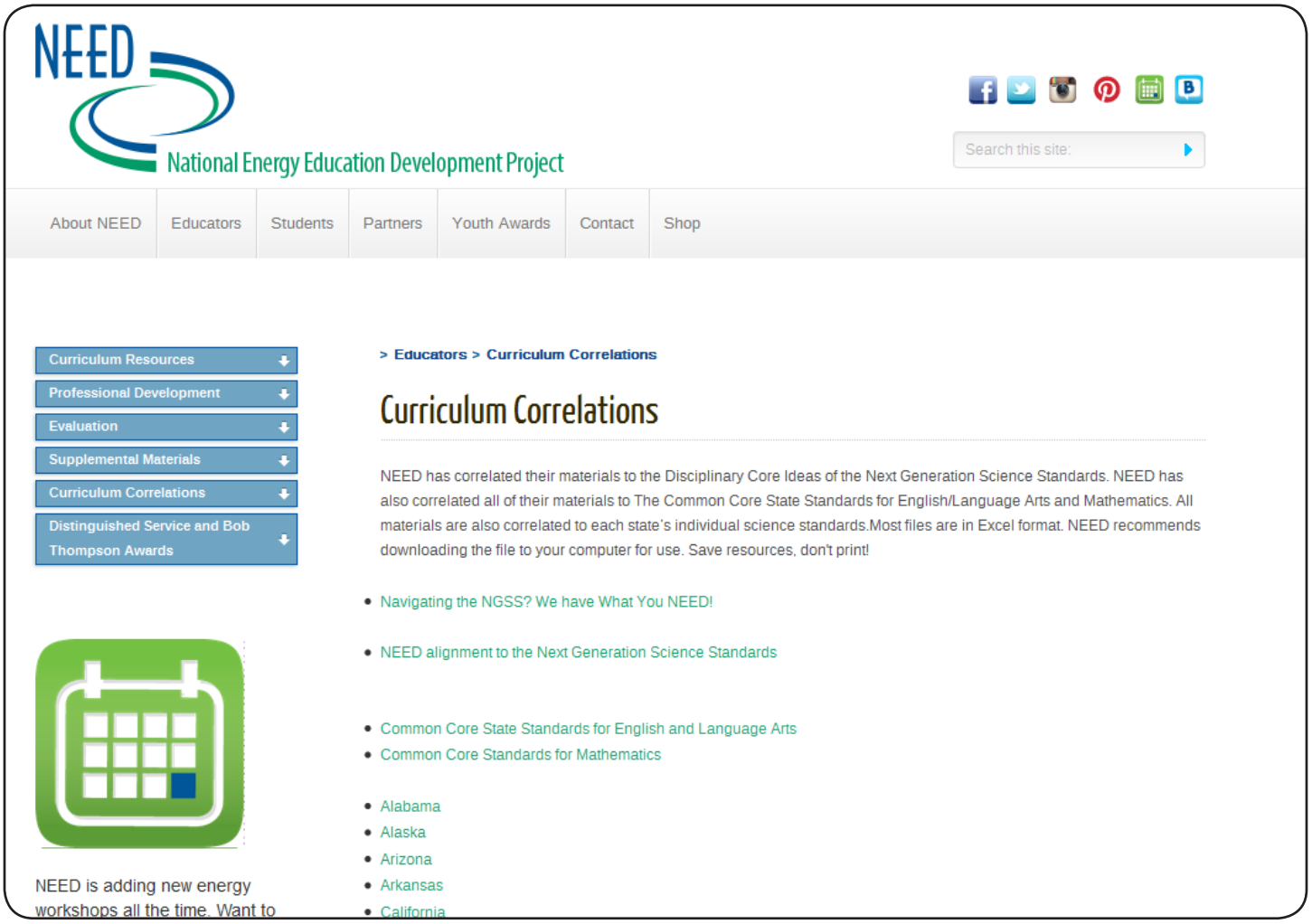
- This guide effectively supports many Next Generation Science Standards. This material can satisfy performance expectations, science and engineering practices, disciplinary core ideas, and cross cutting concepts within your required curriculum. For more details on these correlations, please visit NEED's curriculum correlations web site.

Common Core State Standards

- This guide has been correlated to the Common Core State Standards in both language arts and mathematics. These correlations are broken down by grade level and guide title, and can be downloaded as a spreadsheet from the NEED curriculum correlations web site.

Individual State Science Standards

- This guide has been correlated to each state's individual science standards. These correlations are broken down by grade level and guide title, and can be downloaded as a spreadsheet from the NEED web site.



Teacher Guide

Background

Mission Possible is a cooperative learning activity in which 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 be a perfect reflection of 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 produce consistent amounts of electricity 24 hours a day or in all seasons and weather conditions (wind, solar, hydropower).
- Purchasing decisions and behaviors impact the amount of electricity needed.

Materials and 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*, *Mission Possible Energy Plan*, and *Facts About Energy Sources and Power Plants* for each student, plus one extra copy of the *Mission Possible Energy Plan* for each group.
- Make a copy of the *Sample Energy Plans* to project for students, as needed.
- Make available NEED's *Secondary Energy Infobooks* as resources on the energy sources.
- Make available computers with spreadsheet capabilities. An Excel spreadsheet that can be edited is available for use with this activity. Download it from https://the-need-project.myshopify.com/products/mission-possible.
- If not using the computerized spreadsheet options, students will need calculators, paper, and pencils.
- Make copies of the *Citizens' Council Sheet* for each student or group to evaluate presentations (optional).
- Be prepared to discuss the measurement of electricity with students. Units discussed within this module include kilowatt-hour (kWh) and megawatts (MW). See the "Measuring Electricity" section of the *Secondary Energy Infobook* for more detail, if needed.

✔Procedure

Option 1 (Simple, Computers Needed)

Students use sample environmental impacts and a pre-designed spreadsheet to develop energy plans.

Individual computers with Excel software and the spreadsheet from the NEED web site (pre-loaded) are required.

Grade Levels

- Secondary, grades 9-12

Time

- Five to seven class periods, plus homework.

DAY ONE

- Provide each student with a copy of the *Student Guide* and *Facts About Energy Sources and Power Plants* 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 be a perfect reflection of 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.
- Review the *Student Guide* and answer any questions about the activity. Give the students the sample environmental impact units (shown below) and have them write them on the blank lines in their *Student Guides*. Have students discuss what they think goes into assigning each source its EU, and if they agree or disagree with the sample figures.
- Provide each student with a *Mission Possible Energy Plan*. Explain that the students will use a pre-designed spreadsheet to formulate their individual energy plans. Project one of the *Sample Energy Plans* 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 web site.
- Remind students that there are multiple solutions to this problem, and they may not find the solution within one period. They should be able to defend their choices and decisions even if they do not meet all of their goals.

DAY TWO

- Divide the class into groups of three to five students. Provide a copy of the *Mission Possible Energy Plan* 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 AND 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 act as a Citizens' Council, and vote on each plan after it is presented. If this option is chosen, use the sample *Citizens' Council Sheet* on page 18.

DAY FIVE: EVALUATION AND 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 defending the plan they think is the better option.
- Complete the *Evaluation Form* on page 19 with the class and return it to NEED.

Recommended or Sample Environmental Impact Units

FACILITIES	ENVIRONMENTAL IMPACT UNITS (EU)
Existing Modern Plants	45 EU
Geothermal Plants	6 EU
Hydropower Dams	15 EU
Modernized Coal Plants	40 EU
Natural Gas Plants	30 EU
New Coal Plants	40 EU
Nuclear Plants	25 EU
Solar Plants	3 EU
Waste-to-Energy Plants	6 EU
Wind Farms	2 EU
Ad Campaign for Conservation and Efficiency	-3 EU
Switching to ENERGY STAR® Appliances	-5 EU

Option 2 (Moderate, Technology Intensive)

Students determine environmental impacts and create spreadsheets with formulas provided to develop energy plans.

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

DAY ONE

- Provide each student with a copy of the *Student Guide* and *Facts About Energy Sources and Power Plants* 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 be a perfect reflection of 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.
- Sample environmental impact units have been provided on page 6. 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 difficulty 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 unit 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 plans 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 is reduced by 10, and its capacity is increased by 10 MW.

DAYS TWO AND THREE

- Provide each student with a *Mission Possible Energy Plan* form. Explain that the students will create a spreadsheet to formulate their individual energy plans. Project the *Sample Energy Plans* to explain the assignment to the class.
- Instruct each student to design a spreadsheet of the *Mission Possible Energy Plan* using the formulas on page 9. You can provide all or a few 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.
- Remind students that there are multiple solutions to the problem, and they may not find their solution within the allotted time. They should be able to defend their choices and decisions even if they do not meet all of their goals.

DAY FOUR

- Divide the class into groups of three to five students. Provide a copy of the *Mission Possible Energy Plan* 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 AND 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. If this option is chosen, use the sample *Citizens' Council Sheet* on page 18.

DAY SEVEN: EVALUATION AND 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 defending the plan they think is the better option.
- Complete the *Evaluation Form* on page 19 with the class and return it to NEED.

Option 3 (Challenging, Technology-Intensive)

Students determine environmental impacts and create their own spreadsheets. Individual computers with Excel software are required. Competency is 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 a spreadsheet, using a calculator, paper, and pencil to do the math.

Option 5 (Quick, Not Math-Intensive)

Students select an individual energy plan using analysis and comparison.

- Give students the sample plans from the guide, pages 15-17.
- In groups or individually, they need to determine which plan is best. All plans meet the goal of the council but use a different mix of sources in their solution.
- Students can defend their choice verbally, in a debate, or in writing. Guide them to look not only at the goals, but also look at how these goals were achieved with varying numbers and types of plants.

Extensions

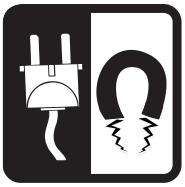
- Have students draw maps of Essowess and its power plants based on their individual plans.
- Have students try to create a solution that has only renewable sources or only nonrenewable sources. Have them explain and discuss their results and complications.
- Have students research the area in which 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.
- Have students create a public service announcement to encourage citizens to conserve energy.
- Have students use NEED's *Facts of Light* (found in the *Monitoring and Mentoring* Student Guide), to find the number of kWh saved by using CFLs. Students should use the amount saved per bulb to determine the number of hours worth of light they must change to build certain types of plants (using plant production figures in their spreadsheets).
    - For example, if they find that "x" number of kWh need to be changed to be equivalent to one hydropower plant, how many bulbs per student would that equal?
- Add in a workforce component - have students research, or research yourself ahead of time, how many individuals are employed or would be employed at each type of power generation facility. Set parameters similar to the economic and environmental components already in place.
- Students who choose to incorporate an ad campaign can take it a step further and research technology to reduce power use (efficiency) and behaviors resulting in reduced power consumption (conservation).

Master Spreadsheet with Formulas

1	A	B	C	D	E	F	G	Reference Figures		
2	MISSION POSSIBLE SPREADSHEET	Number of Power Plants	Capital, Operating, and Maintenance Costs ($)	Generating Capacity (MW)	Environmental Impact Units (EU)	Cost of Electricity per kWh	Total Cost of Electricity from this Source	Capital, Operating, and Maintenance Cost to Add One Plant or Change One	Capacity in MW of One Plant or One Change	Environmental Impact for One Plant or One Change
3	Existing Modern Plants	20	1340	1300	900	0.04	=D3*F3*1,000	———	———	———
4	Old Coal Plants	5	215	275	250	0.04	=D4*F4*1,000	———	———	———
5	Modernized 5 Old Coal Plants	0	=B5*80	=B5*10	=B5*-10	0.04	=D5*F5*1,000	80	10	-10
6	New Coal-Fired Plants	0	=B6*102	=B6*65	=B6*40	0.04	=D6*F6*1,000	102	65	40
7	Geothermal Plants (up to 3)	0	=B7*139	=B7*5	=B7*6	0.05	=D7*F7*1,000	139	5	6
8	Hydropower Dams (up to 2)	0	=B8*43	=B8*50	=B8*15	0.01	=D8*F8*1,000	43	50	15
9	Natural Gas Power Plants	0	=B9*28	=B9*40	=B9*30	0.04	=D9*F9*1,000	28	40	30
10	Nuclear Power Plants (0 or 1)	0	=B10*146	=B10*220	=B10*25	0.03	=D10*F10*1,000	146	220	25
11	Solar Power Plants	0	=B11*67	=B11*15	=B11*3	0.10	=D11*F11*1,000	67	15	3
12	Waste-to-Energy Plants (up to 2)	0	=B12*146	=B12*5	=B12*6	0.04	=D12*F12*1,000	146	5	6
13	Wind Farms (up to 5)	0	=B13*60	=B13*10	=B13*2	0.05	=D13*F13*1,000	60	10	2
14	Ad Campaign for Conservation and Efficiency (0 or 1)	0	=B14*5	=B14*-5	=B14*-3	———	———	5	Need 5 fewer MW	-3
15	Retrofitting Government Buildings with ENERGY STAR® Appliances (0 or 1)	0	=B15*7	=B15*-8	=B15*-5	———	———	7	Need 8 fewer MW	-5
16	TOTALS		=SUM(C3:C15)	=SUM(D3:D13)	=SUM(E3:E15)	———	=SUM(G3:G13)/ D16*1,000			
17	GOAL		2,480	=1,950+B11 +B13+D14 +D15	1,170	———	0.04			

*Rows are numbered as they are in an Excel spreadsheet.

**To switch between formulas and numbers in Excel, push "CTRL +` " at the same time.



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 the environment and the cost of electricity. 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.

Current Energy Portfolio and Goals

	CURRENT STATUS	YOUR GOAL:
Generating Capacity	**1,575 MW**	**1,950 MW or more**
20 Modern Plants @ 65 MW	*1,300 MW*	
5 Old Plants @ 55 MW	*275 MW*	
Economic Cost:	**1,555 energy bucks ($)**	**2,480 energy bucks ($) or less**
20 Modern Plants		
Capital Cost	*0$*	
Operating and Maintenance (fixed) @ 60 $/plant (variable) @ 7 $/plant	*1,340 $*	
5 Old Plants		
Capital Cost	*0 $*	
Operating and Maintenance	*215 $*	
Environmental Cost:	**1,150 enviro-units (EU)**	**1,170 enviro-units (EU) or less**
20 Modern Plants @ 45 EU	*900 EU*	
5 Old Plants @ 50 EU	*250 EU*	
Cost of Electricity:	**$0.04/kWh**	**$0.04/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 decreases and their capacity increases.

TO MODERNIZE EACH OLD PLANT:

Capital Cost (to modernize):	*13 $*
Operating Maintenance Costs (fixed):	*60 $*
Operating Maintenance Costs (variable):	*7 $*
Additional Generating Capacity:	*10 MW*
Additional Environmental Impact:	*-10 EU*
Cost of Electricity:	*$0.04 kWh*

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):

Capital Cost (to build):	*35 $*
Operating and Maintenance (fixed):	*60 $*
Operating and Maintenance (variable):	*7 $*
Generating Capacity:	*65 MW*
Environmental Impact:	*_____ EU*
Cost of Electricity:	*$0.04/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):

Capital Cost (to build):	*45 $*
Operating and Maintenance (fixed):	*84 $*
Operating and Maintenance (variable):	*10 $*
Generating Capacity:	*5 MW*
Environmental Impact:	*_____ EU*
Cost of Electricity:	*$0.05/kWh*

HYDROPOWER PLANTS: The powerful Aichtuwoe River flows from the Osohi Mountains in the east through farmland and a national park to the western border 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):

Capital Cost (to build):	*30 $*
Operating and Maintenance (fixed)	*13 $*
Operating and Maintenance (variable)	*0 $*
Generating Capacity:	*50 MW*
Environmental Impact:	*_____ EU*
Cost of Electricity:	*$0.01/kWh*

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

TO BUILD EACH PLANT (NO MAXIMUM):

Capital Cost (to build):	*10 $*
Operating and Maintenance (fixed):	*15 $*
Operating and Maintenance (variable):	*3 $*
Generating Capacity:	*40 MW*
Environmental Impact:	*_____ EU*
Cost of Electricity:	*$0.04/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. Due to this concern, only one plant can be built until a solution is reached.

TO BUILD EACH PLANT (MAXIMUM 1):

Capital Cost (to build):	*55 $*
Operating and Maintenance (fixed):	*89 $*
Operating and Maintenance (variable):	*2 $*
Generating Capacity:	*220 MW*
Environmental Impact:	*_____ EU*
Cost of Electricity:	*$0.03/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 generating capacity goal of 1,950 MW.

TO BUILD EACH PLANT (NO MAXIMUM):

Capital Cost (to build):	*50 $*
Operating and Maintenance (fixed):	*17 $*
Operating and Maintenance (variable):	*0 $*
Generating Capacity:	*15 MW*
Environmental Impact:	*_____ EU*
Cost of Electricity:	*$0.10/kWh*

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):

Capital Cost (to build):	*40 $*
Operating and Maintenance (fixed):	*101 $*
Operating and Maintenance (variable):	*5 $*
Generating Capacity:	*5 MW*
Environmental Impact:	*_____ EU*
Cost of Electricity:	*$0.04/kWh*

WIND FARMS: There are not many places in Essowess that have consistent winds. Along the eastern mountains, however, the wind blows at a rate that would run wind machines most of the year. Some residents of the mountains 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 generating capacity goal of 1,950 MW.

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

Capital Cost (to build):	*25 $*
Operating and Maintenance (fixed):	*28 $*
Operating and Maintenance (variable):	*7 $*
Generating Capacity:	*10 MW*
Environmental Impact:	*_____ EU*
Cost of Electricity:	*$0.05/kWh*

Other Options

AD CAMPAIGN: In an attempt to get citizens to change energy-wasting behaviors, create commercials, print educational material, and advertisements with tips to conserve energy and to purchase efficient devices. Creating a campaign like this reduces the total amount of electricity needed, and will therefore lower your generating capacity goal of 1,950 MW.

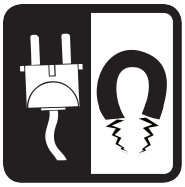
(MAXIMUM 1):

Capital Cost:	*5 $*
Generating Capacity:	*-5 MW*
Environmental Impact:	*_____ EU*

RETROFITTING GOVERNMENT BUILDINGS WITH ENERGY STAR® APPLIANCES: Although it will cost valuable dollars up front, ENERGY STAR® appliances are more efficient than older models, and will save money and energy. You retrofit all government buildings with new, more efficient electrical devices. A program like this reduces the total amount of electricty needed, and will therefore lower your generating capacity goal of 1,950 MW.

(MAXIMUM 1):

Capital Cost:	*7 $*
Generating Capacity:	*-8 MW*
Environmental Impact:	*_____ EU*



Facts About Energy Sources and 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.

Geothermal Power Plants

- Are built on the site of the geothermal reservoir.
- Produce few environmental impacts.
- Use a renewable resource.

Hydropower Plants

- Require 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.

Natural Gas Plants

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

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 on-site in storage facilities.
- Use a nonrenewable resource.

Solar Power Plants

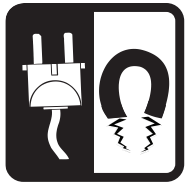
- Cannot produce electricity all of the time.
- Produce no pollution but require large land areas.
- Use energy from the sun that is free to harvest.
- Use a renewable resource.

Waste-to-Energy Plants

- Burn trash to produce electricity.
- Reduce the need for landfill space.
- Produce CO_2 and other limited air pollutants when burned, and can smell bad.
- Use a renewable resource.

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 impact bat and bird populations, but do not pollute the air or water.
- Use an energy source that is free to harvest.
- Use a renewable resource.



Mission Possible Energy Plan

1	A	B	C	D	E	F	G	Reference Figures		
2	MISSION POSSIBLE SPREADSHEET	Number of Power Plants	Capital, Operating, and Maintenance Costs ($)	Generating Capacity (MW)	Environmental Impact Units (EU)	Cost of Electricity per kWh	Total Cost of Electricity from this Source	Capital, Operating, and Maintenance Cost to Add One Plant or Change One	Capacity in MW of One Plant or One Change	Environ-mental Impact for One Plant or One Change
3	Existing Modern Plants	20	1,340	1,300	900	$0.04		———	———	———
4	Old Coal Plants	5	215	275	250	$0.04		———	———	———
5	Modernized 5 Old Coal Plants							80	10	-10
6	New Coal-Fired Plants							102	65	40
7	Geothermal Plants (up to 3)							139	5	6
8	Hydropower Dams (up to 2)							43	50	15
9	Natural Gas Power Plants							28	40	30
10	Nuclear Power Plants (0 or 1)							146	220	25
11	Solar Power Plants							67	15	3
12	Waste-to-Energy Plants (up to 2)							146	5	6
13	Wind Farms (up to 5)							60	10	2
14	Ad Campaign for Conservation and Efficiency (0 or 1)					———	———	5	Need 5 fewer MW	-3
15	Retrofitting government buildings with ENERGY STAR® Appliances (0 or 1)					———	———	7	Need 8 fewer MW	-5
16	TOTALS					———				
17	GOAL		2,480	=1,950+B11 +B13+D14 +D15	1170	———	$0.04			

*Rows are numbered as they are in an Excel spreadsheet.

Sample Energy Plan 1

1	A	B	C	D	E	F	G	Reference Figures		
2	MISSION POSSIBLE SPREADSHEET	Number of Power Plants	Capital, Operating, and Maintenance Costs ($)	Generating Capacity (MW)	Environmental Impact Units (EU)	Cost of Electricity per kWh	Total Cost of Electricity from this Source	Capital, Operating, and Maintenance Cost to Add One Plant or Change One	Capacity in MW of One Plant or One Change	Environ-mental Impact for One Plant or One Change
3	Existing Modern Plants	20	1,340	1,300	900	$0.04	52,000	———	———	———
4	Old Coal Plants	5	215	275	250	$0.04	11,000	———	———	———
5	Modernized 5 Old Coal Plants	5	400	50	-50	$0.04	2,000	80	10	-10
6	New Coal-Fired Plants	0	0	0	0	$0.04	0	102	65	40
7	Geothermal Plants (up to 3)	0	0	0	0	$0.05	0	139	5	6
8	Hydropower Dams (up to 2)	1	43	50	15	$0.01	500	43	50	15
9	Natural Gas Power Plants	1	28	40	30	$0.04	1,600	28	40	30
10	Nuclear Power Plants (0 or 1)	1	146	220	25	$0.03	6,600	146	220	25
11	Solar Power Plants	0	0	0	0	$0.10	0	67	15	3
12	Waste-to-Energy Plants (up to 2)	0	0	0	0	$0.04	0	146	5	6
13	Wind Farms (up to 5)	2	120	20	4	$0.05	1,000	60	10	2
14	Ad Campaign for Conservation and Efficiency (0 or 1)	1	5	-5	-3	———	———	5	Need 5 fewer MW	-3
15	Retrofitting government buildings with ENERGY STAR® Appliances (0 or 1)	1	7	-8	-5	———	———	7	Need 8 fewer MW	-5
16	TOTALS		2,304	1,955	1,166	———	$0.038			
17	GOAL		2,480	1,939	1,170	———	$0.04			

*Rows are numbered as they are in an Excel spreadsheet.

Sample Energy Plan 2

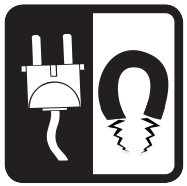
1	A	B	C	D	E	F	G	Reference Figures		
2	MISSION POSSIBLE SPREADSHEET	Number of Power Plants	Capital, Operating, and Maintenance Costs ($)	Generating Capacity (MW)	Environmental Impact Units (EU)	Cost of Electricity per kWh	Total Cost of Electricity from this Source	Capital, Operating, and Maintenance Cost to Add One Plant or Change One	Capacity in MW of One Plant or One Change	Environ-mental Impact for One Plant or One Change
3	Existing Modern Plants	20	1,340	1,300	900	$0.04	52,000	———	———	———
4	Old Coal Plants	5	215	275	250	$0.04	11,000	———	———	———
5	Modernized 5 Old Coal Plants	5	400	50	-50	$0.04	2,000	80	10	-10
6	New Coal-Fired Plants	0	0	0	0	$0.04	0	102	65	40
7	Geothermal Plants (up to 3)	1	139	5	6	$0.05	250	139	5	6
8	Hydropower Dams (up to 2)	1	43	50	15	$0.01	500	43	50	15
9	Natural Gas Power Plants	1	28	40	30	$0.04	1,600	28	40	30
10	Nuclear Power Plants (0 or 1)	1	146	220	25	$0.03	6,600	146	220	25
11	Solar Power Plants	0	0	0	0	$0.10	0	67	15	3
12	Waste-to-Energy Plants (up to 2)	0	0	0	0	$0.04	0	146	5	6
13	Wind Farms (up to 5)	1	60	10	2	$0.05	500	60	10	2
14	Ad Campaign for Conservation and Efficiency (0 or 1)	1	5	-5	-3	———	———	5	Need 5 fewer MW	-3
15	Retrofitting government buildings with ENERGY STAR® Appliances (0 or 1)	1	7	-8	-5	———	———	7	Need 8 fewer MW	-5
16	TOTALS		2,383	1,950	1,170	———	$0.038			
17	GOAL		2,480	1,938	1,170	———	$0.04			

*Rows are numbered as they are in an Excel spreadsheet.

Sample Energy Plan 3

1	A	B	C	D	E	F	G	Reference Figures		
2	MISSION POSSIBLE SPREADSHEET	Number of Power Plants	Capital, Operating, and Maintenance Costs ($)	Generating Capacity (MW)	Environmental Impact Units (EU)	Cost of Electricity per kWh	Total Cost of Electricity from this Source	Capital, Operating, and Maintenance Cost to Add One Plant or Change One	Capacity in MW of One Plant or One Change	Environ-mental Impact for One Plant or One Change
3	Existing Modern Plants	20	1,340	1,300	900	$0.04	52,000	———	———	———
4	Old Coal Plants	5	215	275	250	$0.04	11,000	———	———	———
5	Modernized 5 Old Coal Plants	5	400	50	-50	$0.04	2,000	80	10	-10
6	New Coal-Fired Plants	0	0	0	0	$0.04	0	102	65	40
7	Geothermal Plants (up to 3)	0	0	0	0	$0.05	0	139	5	6
8	Hydropower Dams (up to 2)	2	86	100	30	$0.01	1000	43	50	15
9	Natural Gas Power Plants	0	0	0	0	$0.04	0	28	40	30
10	Nuclear Power Plants (0 or 1)	1	146	220	25	$0.03	6,600	146	220	25
11	Solar Power Plants	0	0	0	0	$0.10	0	67	15	3
12	Waste-to-Energy Plants (up to 2)	0	0	0	0	$0.04	0	146	5	6
13	Wind Farms (up to 5)	4	240	40	8	$0.05	2000	60	10	2
14	Ad Campaign for Conservation and Efficiency (0 or 1)	1	5	-5	-3	———	———	5	Need 5 fewer MW	-3
15	Retrofitting government buildings with ENERGY STAR® Appliances (0 or 1)	1	7	-8	-5	———	———	7	Need 8 fewer MW	-5
16	TOTALS		2,439	1,985	1,155	———	$0.0378			
17	GOAL		2,480	1,941	1,170	———	$0.04			

*Rows are numbered as they are in an Excel spreadsheet.



Citizens' Council Sheet

Team Name: _____ Council Person's Name: _____

Project met budget _____ yes _____no	Summary of advantages/disadvantages:	Approved?
Project met energy demand _____ yes _____no	Summary of advantages/disadvantages:	Approved?
Project did not exceed Environmental Impact Units (EU) _____ yes _____no	Summary of advantages/disadvantages:	Approved?
Project kept energy costs low _____ yes _____no	Summary of advantages/disadvantages:	Approved?
	Overall Project with Defense - Approved or Denied?	

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 teach this activity again?	❑ Yes	❑ No

Please explain any 'no' statement below.

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 unit more useful to you?

Other Comments:

Please fax or mail to: **The NEED Project**
8408 Kao Circle
Manassas, VA 20110
FAX: 1-800-847-1820

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