CASE STUDY – UNIT 3

The Case of the New Power Plant

Teaching Instructions

Overview

In this case study, students analyze the trade-offs involved in developing new sources of electricity, discovering in the process that there are no easy answers. Every energy source involves both costs and benefits. Our choice of the "best" source for us depends upon the weights that we assign to various criteria.. Students will discover that there are opportunity costs involved in the production and consumption of energy, regardless of the source.

Learning Objectives

After completing this case study, students will:

1. Explain that every choice involves an opportunity cost.
2. Identify the costs and benefits of the following three sources of electricity: coal, nuclear, and solar.
3. List the costs and benefits of energy conservation.
4. Use the Five-Step (PACED) decision-making process to weigh alternatives for eliminating a shortage of electricity.

Prerequisite Skills

Students should know how to use the Five-Step (PACED) decision-making model to make personal or social decisions.

Important Concepts T o Emphasize

1. **No energy source is costless.** All energy sources involve some combination of environmental costs, health risks, loss of renewable resources, space requirements, and/or high development costs. There is no unambiguous "right" energy source: each source involves compromise, and every society must weigh all of the short- and long-term costs and benefits in deciding upon the proper mix of energy sources.

2. **Conservation can be an effective way to stretch scarce energy resources, but even conservation involves costs.** For example, turning down our home thermostats can save a lot of energy, but it can also cause discomfort, or in the case of the aged or the sick, promote health risks. Conservation means using our scarce energy resources so they provide the greatest benefit to society. It does not mean simply making them last as long as possible, which would require that we never use them.

3. **Energy efficiency is not the same thing as economic efficiency.** All of our resources are scarce, not just energy resources. Maximizing economic efficiency means getting the greatest benefit from **all** of our scarce resources; a goal of maximizing energy efficiency puts no value on other scarce resources. For example, we could make automobiles today that average more than 100 mpg, but society is not willing to pay the cost (i.e. opportunity cost) in terms of lack of power, crash protection, and payload. Similarly, solar cars are very energy efficient, but they are not yet economically efficient.

Teaching Suggestions

1. Review the Five-Step (PACED), decision-making model. 1. Define the **P**roblem; 2. List **A**lternatives; 3. Identify **C**riteria/Goals 4. **E**valuate Alternatives Against the Criteria; 5. Make a **D**ecision. Show students how to use the Decision-Making Grid. (See end of lesson.)

2. Hand out the attached scenario and decision-making grid to your students. Ask students to evaluate each of the options, filling in the alternatives and criteria they think are important, based on the scenario. You may wish to divide the class

into special interest groups, each supporting a different alternative. If time permits, you may wish to have your students try "The Geologist's Dilemma," which is an excellent simulation of energy production from various sources, using black and blue beads and corn meal to represent coal, gas, and solar power.

Key Questions To Ask Students

1. What are the advantages of each source of electrical power? What are the disadvantages?

   Coal: The main advantages are its relative abundance and low price. The U.S. has more coal than any other nation, with a supply for more than 300 years at today's rate of use. The primary disadvantages are the dangerous nature of coal mining and the high levels of emissions, including nitrogen, sulfur, mercury, and carbon dioxide.

   New technologies are now making coal power plants much cleaner and more efficient. Coal-fired power plants using new Integrated Gasification Combined Cycle (IGCC) technology are more efficient in electric production and use less water for cooling. CO_2 emissions can also be trapped more effectively. However, because the technology is new, it is 20-30% more expensive.

   Nuclear: The advantages include the potential to produce energy with low fuel costs and no air pollution. The disadvantages are devising ways to dispose of radioactive waste and the possibility, however slight, of a catastrophic accident.

   Solar: Advantages include low operational costs and no pollution. On the down side, solar power is land intensive with high initial expense. Further, output depends on the weather, requiring sunny days.

   Natural Gas: Natural gas power plants are cleaner than coal plants and can be brought on-line very quickly. Natural gas plants produce electricity more efficiently than coal plants and produce it with fewer emissions. However, natural gas is a fossil fuel and does release pollutants into the atmosphere. Because we also use it to heat our homes, natural gas is expensive, subject to wide swings in price, and costly relative to other fuels. In addition, environmental concerns have limited the areas where companies are allowed to drill.

2. What are the advantages and disadvantages of conservation as an alternative to building a new power plant? Some people argue that conservation is a "free" source of energy. Do you agree? Can you think of anything else that is free?

   Conservation can stretch our energy resources, reducing or eliminating the need for additional generating capacity. However, even conservation is not "free." We use heating and cooling for comfort and health reasons. Giving that up, even in part, means making a sacrifice, especially for the very old and the very young. Actually, few things are truly free. Virtually everything involves a cost. Students sometimes argue that friendship or love is free, but we must work to achieve and maintain them, so they are not really costless.

3. After filling in the decision grid, which solution in the case study do you think would be best for Growville? Explain your decision.

   Even after filling in the grid (see the following example), there may not be a clear-cut answer. The "best" choice for Growville depends on the relative importance of the different criteria or goals.

Other Teaching Materials

1. "The Geologist's Dilemma," from *Energy Tradeoffs in the Marketplace*. Washington State Council on Economic Education, and Superintendent of Public Instruction, State of Washington, 1980. (Check with your local Center for Economic Education regarding availability – www.ncee.net)

2. For teachers, probably the best source of information about energy is the NEED (National Energy Education and Development) Project. Teachers can access a wealth of balanced, age-appropriate information about all sources of energy. See http://www.need.org/EnergyInfobooks.php

DECISION GRID ANSWER KEY
The Case of the New Power Plant

	CRITERIA				
ALTERNATIVES	Solve shortage	Safety risk	Pollution	Convenience	Low Cost
Coal	+	?	-	+	+
Nuclear	+	-	+	+	+
Solar	?	+	+	-	-
Conservation	+	?	+	-	?
Natural Gas	+	+	?	+	- -
Do Nothing	-	+	+	-	?

The Case of the New Power Plant

Student Directions:

You are members of the city council in the booming city of Growville. You must evaluate several proposals for dealing with a growing shortage of electricity. After evaluating the proposals, fill in the Decision Worksheet and Decision-Making grid, using the Five-Step decision model to decide which recommendation to accept.

Scenario:

Growville is enjoying a period of economic growth that most other cities can only dream about. It has grown from a small city to a thriving metropolis with plenty of jobs and a high standard of living. Luckily, it has avoided the big-city problems of crime and pollution that plague many other communities during their boom periods. It has become a place where people want to live and a place where businesses want to locate. As a result, the population has doubled during the past 20 years; however, the electricity is produced in a power plant built in 1947 for a much smaller population. During a heat wave last summer, so many air conditioners were turned on that power outages occurred all over town. The situation is expected to get worse in the future.

While sitting in a popular barber shop waiting for a hair cut, Mr. Alvarez, President of the Growville Chamber of Commerce, complained loudly to everyone within earshot that without a new power plant the city and other smaller cities in the region could forget about economic growth or even about having sufficient capacity to meet residents' current needs. He argued that the cheapest way to meet the community's energy demand is to build a new coal-fired power plant.

The barber, Sally Friedman, responded that nuclear power would be more economical, particularly if one considered the environmental costs of both producing and using fossil fuels. "The safety record of nuclear power is better than that of other energy sources," stated Ms. Friedman. "We have built so many fail-safe mechanisms into our nuclear plants that the odds against a major accident are astronomical." Mr. Alvarez countered that coal is our most plentiful energy resource, and that modern power plants can burn coal very economically and in an environmentally responsible manner. He added, "Even though the odds are heavily stacked against a major incident at a

nuclear power plant, if it does happen, it will be catastrophic. Are we prepared to take that risk?"

Mr. Brown encouraged everyone to consider natural gas power plants. These are more efficient than coal and emit less pollution. "True," said Mr. Alvarez, "but the price of natural gas fluctuates a lot due to changing supply and demand. Recently, demand has been very high and the price has soared. This has been tough on people – especially those with low incomes. Coal is so much cheaper.

Fred Simpson, who manages a local Dairy Queen, reminded the group that his restaurant is solar powered. "Why can't we use some of that vacant land just west of town to build giant solar collectors to generate power to meet the city's growing energy demand?" asked Fred. "This would be essentially free electricity from the sun waiting for us to take it. And there would be no pollution!"

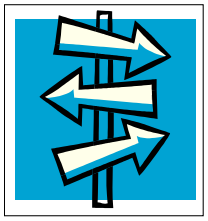
Mr. Alvaraz reminded the others that *any* energy source involves some costs. For example, solar collectors are expensive to build, take a lot of valuable space that could be used for other purposes, and produce energy only on sunny days. Do you really want higher electric bills resulting from solar power?

Ben Johnson, who was active in several environmental groups, argued that people simply needed to cut back, that their energy consumption was wastefully high. He pointed out that just setting the thermostat a few degrees higher in the summer and lower in the winter would save enough energy to avoid a shortage without the environmental cost of building new facilities for generating electricity. "Furthermore," he added, "we don't need those ridiculously long hours of operation at the mall. Why don't we just require stores to reduce their hours of operation? Surely 10 hours per day is enough. The malls should close at 7:30 p.m."

Sally Friedman responded, "Ben, that sounds great, but what about people whose health prevents them from lowering their thermostats? And how about my daughter and her friends, who would rather give up food and shelter than cut back on trips to the mall! How do we decide for other people which 'needs' are more important?"

The discussion died down without the group reaching a consensus. What decision should be made?

Decision Worksheet



Student Directions

1. Complete this worksheet and the Decision-Making Grid to help you analyze the case study.
2. (Optional) Below the evaluation marks you place in each cell of the decision-making grid, make a brief comment explaining **why** you made a particular mark.

Step 1: Define the Problem

_____

_____

Step 2: List Alternative Solutions

_____

_____

_____

_____

Step 3: List Important Criteria

_____

_____

_____

_____

Step 4: Evaluate Alternative Solutions

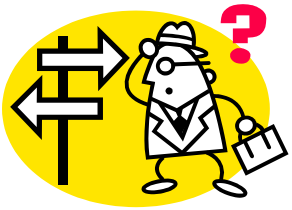
(Fill in the individual cells in the decision-making grid.)

Step 5: Make A Decision

(Which alternative do you think is the best solution?)

_____

Decision-Making Grid



Name _____ Class _____

CRITERIA					
ALTERNATIVES					