Energy in Society Game

Spreadsheet Activity for Students grades 5-12

- from the Eastern Oregon Renewable Energies Non-profit

What is a Decision Matrix/Selection Matrix?

Have you ever had to make a decision with too many options or factors to consider all at once? Or perhaps you'd like to be more objective about your choices. Or maybe you need to document your decision to make it more defensible later on.

A decision matrix is a chart that allows a person or team to systematically identify, analyze, and rate the strength of relationships between sets of information. The matrix is especially useful for looking at large numbers of decision factors and assessing each factor's relative importance. A decision matrix is frequently used during quality planning activities to select product/service features and goals and to develop process steps and weigh alternatives. For quality improvement activities, a decision matrix can be useful in selecting a project, in evaluating alternative solutions to problems, and in designing remedies.

The Energy in Society Spreadsheet Game is a Decision Matrix that takes into account complicated factors such as political factors, the environmental and cost ramifications of different power sources, and the spreadsheet user's personal values. The resulting graph displays a suggested balance of energy sources that best suits the user's values and current practical limitations. Users will find it useful when making decisions for themselves and their communities. Students will find that it prompts curiosity about energy sources and energy use. It will spur them to research alternatives and think critically about personal choices.

How to Use the ***Energy in Society*** *Decision Matrix*

Directions for Teachers:

Teachers or advanced users can change values in the Yellow cells (on sheet "X"), which represent the user's opinion of the ramifications for each combination of energy source and merit function. Energy sources are listed in the column to the left of the yellow cells, and numbers corresponding to the merit functions are listed in the purple band across the top. Suggested values have been included.

Notes for teachers:

Suggested student activity: Divide the class into "research" teams, one for each energy source.

Teams will present their findings to the group as a whole. They are not "promoting" their power source, they are trying to describe their energy source, find out what both promoters and detractors say about that energy source, and present a picture for their classmates.
If you separate out energy-source decision making from energy use decisions like conservation, you effectively decrease your options for making energy-source decisions.

Teacher Script (read to students):

You are building a new community, and you are going to have to choose energy sources for your homes and businesses. These energy sources will provide heat and lighting, as well as power all your appliances (refrigeration, cooking, and electronics). What choices will you make? Will your energy sources reflect your personal values, i.e. are you going to feel good about what your utility payments are supporting while you keep warm and comfy? Also, are you going to be able to continue using these same sources of energy as the years pass? Are your energy sources plentiful and cost-effective? This classroom activity will help you see what some of the effects of your energy decisions will be.

1) Fill in the green cells to represent how important you think each of the merit functions is to you. Think carefully about your values. Which is more important to you, cheap power or clean water? Reliability, or "not in my backyard"?
2) Use numbers between 0 and 10 to represent your relative values. You can "test" the weighted values by turning them into sentences. For example, you'd say something like: "It's three times as important to me to have power plants that are not in my backyard, as it is to have inexpensive power." For anything that sounds wrong, you can adjust the relative weights.
3) Make sure that the average of the cells, as seen at the bottom of the green column, is 5. If the "average" is above 5, lower some values a little at a time until the average reaches 5. If it is below 5, raise some of the values a little at a time.
4) Look at graph at the bottom of the spreadsheet to observe the results. The graph displays which mix of energy sources will best suit your personal values and opinions.

Inquiry Questions for Students:

1) How is energy made from this source, distributed or transmitted, and used?
2) What is the origin of this energy source (i.e. from the sun, by transformation of vegetable matter and climate, or if it's from mineral resources, etc.)?
3) What transformations take place to change the energy source into usable energy?
4) Are other resources (for example, clean water) consumed or transformed in the production of energy from this source?
5) What is the efficiency of energy made from this source (i.e. how much of the original energy is lost between origin and use, and what happened to it)?
6) What, if any, are the effects on climate from the extraction, processing, and use of this energy source?
7) If we need to create more energy production from this source, will it cost more, less, or the same as existing production capability (example: existing hydroelectric is fairly cheap, but new hydro is hardly possible at any price)?
8) What are some of the "pluses" and "minuses" of this energy source? What do supporters and detractors say about it?

Inquiry Notes for Students:

Thermal plants like gas, coal, and most biomass consume huge amounts of clean water. As much as a third of all fresh water in the US goes to cool thermal power plants. A lot of this is pumped out of aquifers (some are irreplaceable fossil water), and then dumped (still warm) into surface waters.

Read the paper "*Wind Energy and Wildlife*" at the American Wind Energy Association website (www.awea.org/pubs/factsheets/Wind_Energy_and_Wildlife_Mar09.pdf).

Solar thermal and solar electric have very different characteristics. Solar thermal, especially passive solar, is nearly without negatives in the merit list, it's even cheap! When you consider solar, please consider *both* solar thermal and solar electric.

Web Resources for students:

Note: these are only a few of the available sources, and only a starting point for your research! The facts are not always available from a totally unbiased source. Some energy sources may not be very controversial. A few are covered admirably, both pro and con, by a single site! So start here, and let your curiosity find out about all kinds of energy sources!

Bioenergy:
Pros and Cons: www.masstech.org/cleanenergy/biomass/benefitsbarriers.htm

Coal:
Pro: www.teachcoal.org/index.html
Con: www.coal-is-dirty.com/
The facts: www.worldcoal.org/pages/content/index.asp?PageID=188

Geothermal Energy:
Pros and Cons: www.darvill.clara.net

Heating Oils:
Pro: www.oregonoilheat.com/ or www.factsonfuel.org/heating_oil/index.html
Con: www.rtcc.org/2009/html/dff-1.html
The Facts: www.fossil.energy.gov/programs/reserves/heatingoil/

Hydroelectric:
The facts: www.enviroliteracy.org/article.php/59.html

Natural Gas:
Pro: www.naturalgas.org
Con: www.energyjustice.net/naturalgas/
The Facts: www.eia.doe.gov/kids/energyfacts/sources/non-renewable/naturalgas.html

Nuclear Energy:
Pro: www.nei.org/
Con: www.ucsusa.org/nuclear_power/

Solar:
Pros and Cons: http://library.thinkquest.org/26366/text/alternative/solar.html
The Facts: www1.eere.energy.gov/solar/pv_quick_facts.html

Wave Energy:
Pro: http://eecs.oregonstate.edu/wesrf/
The Facts: www.wavesenergy.com/

Wind Energy:
Pro: www.awea.org
Con: www.windaction.org

Energy Fact Overviews: www.solarenergy.org/resources/energyfacts.html
US Dept of Energy "Energy Sources" page: www.energy.gov/energysources/index.htm

Meets the Following Standards for Science Teaching

Benchmark 3 (Grades 6-8) students compare properties of substances and physical and chemical changes. They study interactions between force and matter and relationships among force, mass, and motion. Students compare forms and behaviors of types of energy. They also examine energy transfers and transformations.

Energy: Understand energy, its transformations, and interactions with matter.

SC.08.PS.05 Compare forms and behaviors of various types of energy.

SC.08.PS.05.01 Distinguish between the forms of energy including heat, chemical, mechanical, and gravitational potential energy.

SC.08.PS.06 Describe and explain various energy transfers and resulting transformations.

SC.08.PS.06.01 Trace the flow of energy transformations in a system.

SC.08.PS.06.02 Explain the principle that energy is conserved, neither created nor destroyed.

SC.08.PS.06.03 Identify how technological advances have changed humankind's use of energy.

Forming the Question/Hypothesis: Formulate and express scientific questions or hypotheses to be investigated.

SC.08.SI.01 Based on observations and scientific concepts, ask questions or form hypotheses that can be explored through scientific investigations.

High school students analyze the effects of factors on physical changes and chemical reactions. Students learn the effects of multiple forces acting on an object. They study differences and similarities between kinds of waves as a means of transmitting energy and analyze examples of conservation of energy. Students learn how the importance and use of resources has changed over time with changes in economic and technological systems, and the relationship between global energy transfer and climate.

Energy: Understand energy, its transformations, and interactions with matter.

SC.HS.PS.05 Describe differences and similarities between kinds of waves, including sound, seismic, and electromagnetic, as a means of transmitting energy.

SC.HS.PS.05.01 Recognize that waves of all kinds have energy that can be transferred when the waves interact with matter.

SC.HS.PS.05.02 Apply the concepts of frequency, wavelength, amplitude, and energy to electromagnetic and mechanical waves.

SC.HS.PS.06 Describe and analyze examples of conservation of energy.

SC.HS.PS.06.01 Recognize that heat energy is a by-product of most energy transformations.

SC.HS.PS.06.02 Describe ways in which energy can be transferred, including chemical reactions, nuclear reactions, and light waves.

SC.HS.PS.06.03 Explain the difference between potential and kinetic energy.

SC.HS.PS.06.04 Analyze the flow of energy through a system by applying the law of conservation of energy.

Forming the Question/Hypothesis: Formulate and express scientific questions or hypotheses to be investigated.

SC.HS.SI.01 Based on observations and scientific concepts, ask questions or form hypotheses that can be answered or tested through scientific investigations.

www.ode.state.or.us/search/results/?id=22: