Unit Title: Energy, Climate Status, and You! Main Topics: Fossil Fuels, Renewable and Nonrenewable Energy, Linking Renewable Energy to Montana, and Careers in Renewable Energy.
Grades: 5-8

Duration of Unit: 10 -12 days (±teacher options to make this a 4 week unit) (50 minute periods)
NOTE: Fields of Energy DVD which compliments this unit may be ordered free of cost from lbrenneman@mt.gov or at aginmontanaschools.org

STAGE 1 – DESIRED RESULTS

Montana State Standards:
Science: Content Standard 2 - Students, through the inquiry process, demonstrate knowledge of properties, forms, changes and interactions of physical and chemical systems. ELE: A, B, C.
Language Arts: Content Standard 1: Students know and understand the role of the communication process and demonstrate effective speaking and listening skills. Benchmark Benchmarks 1.4, 1.5, 1.6; 2.6, 2.7, and 2.9 **Content Standard 4**: Students effectively evaluate and create media messages. 4.2 **Content Standard 5**: Students effectively evaluate and create media messages. Benchmark 5.3, 5.12, and 5.13.

Math: Content Standard 1 – Students engage in mathematical processes of problem solving and reasoning, estimation, communication, connections, and applications, and using appropriate technology. Benchmarks 1.1, 1.2, 1.3 **Content Standard 5** – Students demonstrate understanding of measurable attributes and an ability to use measurement process. Content Standard 6 – Students demonstrate understanding of an ability to use data analysis, probability, and statistics. Benchmark 6.2

Social Studies: Content Standard 3 - Students apply geographic knowledge and skills (e.g., location, place, human/environment interactions, movement, and regions). Benchmark 5.1, 5.2, 5.3, and 5.5

Workplace Competencies Content Standard 6 –The foundation for a rewarding life and productive employment is built through exploration and an understanding of life and career choices.

Understanding(s) /Big Ideas:
Students will understand energy. Students will identify fossil fuels and alternative energy sources. Students will distinguish the differences between nonrenewable and renewable resources. Students will understand sustainable, renewable, and Montana's role in energy.

Essential Question(s):
Truth in information? What is energy?
What is fossil fuel?
What are alternatives to fossil fuels: The renewable energy sources?
Can Montana generate alternative energy?
What are the careers in renewable energy?

Students will know:

Students will be able to:

Students will know that Montana has the potential to provide alternative energy.	Describe fossil fuels, alternative energy sources, and link alternative energy to Montana. Students will be able to describe careers in alternative energy.

STAGE 2 – ASSESSMENT EVIDENCE

Performance Task(s):	Other Evidence:
Students will form group discussions and present arguments for their decisions. Students will engage in decision making criterion. Energy Kids Quiz. CO2 energy and the environment statistics.	Students will interpret information and categorize the information into sections. Students will complete assessments in lab lessons.

STAGE 3 – LEARNING ACTIVITIES

Learning Activities:

Lesson 1: Topic: Dihyrodgen Monoxide

Dihyrodgen Monoxide is being used in America! Over 6 million people have visited the coalition against Dihydrogen Monoxide website, will you join the movement?

Prep: Make 10 copies of handout Day 1, Activity 1 A (found in worksheet section)

Divide class into 10 groups, hand out worksheet, "What is your opinion on Dihydrogen Monoxide?" Have groups read handout and brainstorm arguments which are either for abolishing or for supporting Dihydrogen Monoxide use in the United States.

Assessment Activity:

Groups will write one complete paragraph either for or against the ban of Dihydrogen Monoxide. Groups will then present their arguments to the class.

Reveal the true compound labeled as Dihydrogen Monoxide is actually water! Discuss the importance of critical thinking, identifying reliable technology sources, and researching information on the internet. Discuss the

Notes:

Lesson 2: Topic 2A: Intro to Energy

Energy is the ability to do work. When we use electricity in our home, the electrical power was probably generated by burning coal, by a nuclear reaction, or by a hydroelectric plant at a dam. Therefore, coal, nuclear, and hydro are called energy sources. When we fill up a gas tank, the source might be petroleum made from fossil fuels or ethanol made from processing wood, wheat straw, barley

straw, corn and corn stover, switchgrass, rice straw, milo stubble, and other agricultural wastes.

Energy comes in different forms:

- Heat (thermal)
- Light (radiant)
- Motion (kinetic)
- Electrical
- Chemical
- Nuclear energy
- Gravitational

Energy is in everything. We use energy in everything we do, from making a jump shot to baking cookies to sending astronauts into space.

There are two types of energy: stored (potential) energy and working (kinetic) energy. For example, the food you eat contains chemical energy, and your body stores this energy until you release it when you work or play.

Energy Sources can be categorized as Renewable or Nonrenewable

Energy sources can be divided into two groups — Fossil fuels are **nonrenewable resources** – energy sources that, once they are used up, cannot be replaced. However, **renewable resources** are ones that can be "renewed" or made available forever.
Agricultural scientists, engineers, and farmers have been working with both
plants and animals to grow more than food, they are working to develop renewable energy sources!
Renewable and nonrenewable energy sources can be used to produce secondary energy sources including electricity and hydrogen.

Prep: For hands on learning in this lesson gather fossil fuel samples and a sheet of poster board. Use the directions in Topic 4 to draw a triangle and label the points on the poster board, a triangle with 2' sides is recommended for this exercise.

Topic 2B: Nonrenewable energy

Nonrenewable Energy

We get most of our energy from nonrenewable energy sources, which include the fossil fuels

— oil (fossil fuel liquid), natural gas (fossil fuel gas), and coal (fossil fuel solid). They're called fossil fuels because they were formed over millions and millions of years by the action of heat from the Earth's core and pressure from rock and soil on the remains (or "fossils") of dead plants and creatures like microscopic diatoms. One of the problems we face when consuming nonrenewable energy is carbon dioxide emissions. The burning of fossil fuels such as gasoline, coal, oil, natural gas in combustion reactions results in the production of carbon dioxide. Carbon dioxide (CO_2) is emitted in a number of ways. It is emitted naturally through the carbon cycle and through human activities like the burning of fossil fuels.

Activity 2A: Students will complete the Q/A at the following website to see what their family impact is on the environment, and then have the students report back on how many trees they would have to plant to equalize their families CO_2 emissions. (Choose the tree

calculator link, input a variety of data, including diesel fuel).
http://www.coolkidsforacoolclimate.com/Cool%20Kids%20Project/ProjectIndex.htm

Activity 2B: Students will take this interactive quiz as group.
http://tonto.eia.doe.gov/kids/energy.cfm?page=quiz

Activity 2C: Students will hypothesize about the meaning of each puzzle piece. Project the puzzle from this website onto your screen or have students visit this website to identify the lingo (slang) of energy:
http://tonto.eia.doe.gov/kids/energy.cfm?page=energy_slang

±Teacher option for extended lessons on fossil fuels:
http://www.fe.doe.gov/education/energylessons/index.html
http://tonto.eia.doe.gov/kids/energy.cfm?page=2
http://www.coaleducation.org/lessons/middle.htm

±Teacher option for extended lessons climate status:
http://www.keystonecurriculum.org/2008middleschool/MAIN_nav/MSportal.html
http://downloads.climatescience.gov/Literacy/Climate%20Literacy%20Booklet%20Low- Res.pdf
http://www.earthsciweek.org/

Notes:

Lesson 3: Topic 3: What do you know about renewable energy sources?

Key Terms

Sustainable (Meeting the needs of the present without compromising the ability of future generations to meet their own needs).

Renewable energy (an energy source that can be easily replenished).

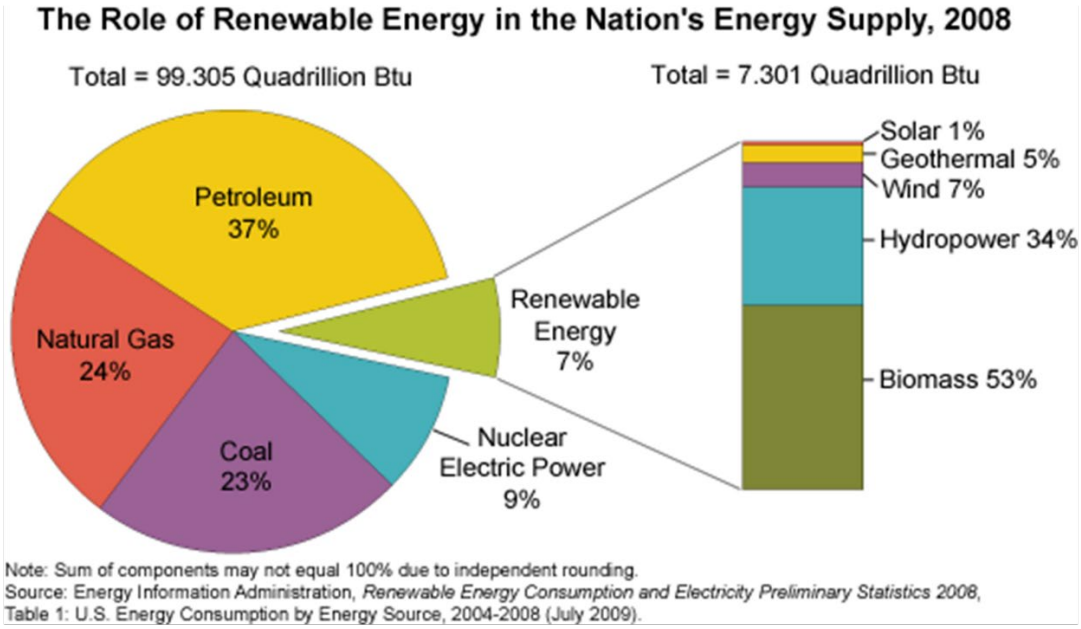
Accessible (The alternative energy source is accessible, in this case in Montana)

(Hint: after completing this exercise, try out other key terms such as pollution, jobs created, etc. and compare triangles)

We use renewable and nonrenewable energy sources to generate the electricity we need for our homes, businesses, schools, and factories. Electricity "energizes" our computers, lights, refrigerators, washing machines, and air conditioners, to name only a few uses.

Most of the gasoline used in our cars and motorcycles and the diesel fuel used in our trucks are made from petroleum oil, a nonrenewable resource. Natural gas, used to heat homes, dry clothes, and cook food, is non-renewable. The propane that fuels our outdoor grill is made from oil and natural gas, both non-renewable.

Discussion: Now that we understand nonrenewable energy sources, the next sections will focus on renewable energy sources. At this time discuss with students what they already know about alternative energy and their personal knowledge and interests. Looking at the graphs below, discuss the importance of renewable energy in terms of percentages of nonrenewable that we currently consume. What will the future of energy look like? Discuss the importance of energy to the entire world, brainstorming some of the essential reasons for energy like food and health care.



http://tonto.eia.doe.gov/energy_in_brief/renewable_energy.cfm

The chart above shows what energy sources the United States uses. Nonrenewable energy sources account for 93% of all energy used in the Nation. Biomass, the largest renewable source, accounts for over half of all renewable energy and 3.7% of total energy consumption. (Note: 53% of 7% is 3.7%.)

The United States Is Second in Renewable Electricity Production

China leads the world in total renewable energy consumption for electricity production due to its recent massive additions to hydroelectric production, followed closely by the United States, Canada, and Brazil. However, the United States consumes the most non-hydro renewable energy for the production of electricity. The United States consumes twice as much non-hydro renewable energy for electricity production as Germany and more than three times as much as Japan.

Even with the US's ranking in renewable energy production the nation is still heavily reliant on nonrenewable energy.

Discussion: How can we move away from our dependence on nonrenewable energy sources? Poll students to see if they agree with the statement below.

Everything that can be invented has been invented.

Charles H. Duell, *Commissioner, U.S. patent office, **1899** (attributed)*

Prep: Read activity 1 below. Make enough copies of #1 - #5 below so that each student in a group is given one copy of their renewable energy resource topic sheet.
Activity1: Discuss the renewable energy sources as part of the pie chart above. Divide the class into 5 groups and assign each group one of the renewable energy sources below. Assign each group the task of defining one of the renewable energy resources beyond the information provided. Assign groups to investigate facts about their renewable energy source from the websites listed. Fact sheets must include several statements about their renewable energy source relating to two of today's three key terms: sustainable and renewable energy.
Students will need this fact sheet ready for tomorrow's lesson.

#1 Solar
As anyone who has ever spent a day playing or working in the summer heat can tell you, the sun is an incredibly impressive source of energy. Even from a distance of 93 million miles, then sun's rays are still power-packed. That's why scientists and engineers work on technology to collects the sun's rays and turns it into electricity. The electricity created this way is called solar power. Solar power is an environmentally friendly alternative to some other power-generating methods. This is because the sun's energy is renewable, which means as long as the sun shines we will never run out of solar energy. And solar power production does not create significant air, water, or land pollution. The United States Environmental Protection Agency says that every year the sun bombards the earth with 1,000 times the energy we get from burning fossil fuel. The trick is to figure out how we can harness that incredible energy!

- Solar energy from the sun, which can be turned into electricity and heat http://tonto.eia.doe.gov/kids/energy.cfm?page=solar_home-basics

#2 Wind Power
Wind power is the fastest-growing non-exhaustible energy source in the world. In the United States alone, wind turbines valued at nearly two billion dollars were operational in 2003 – enough to power about 800,000 homes. Wind power is growing in popularity throughout the United States partly as a result of improvements in technology and partly in response to savings offered by state and federal energy programs.

"Wind farms" reduce air pollution and keep the environment clean for future generations. Wind energy also makes us less dependent on fossil fuels and encourages the development of renewable and nonexhaustible energy sources. In 2009 there were over 29,000 wind power sites in the US, with nearly 6,000 more under construction. When choosing an area for wind power many factors must be considered, from wind speeds to migratory bird flyways.

- Wind http://tonto.eia.doe.gov/kids/energy.cfm?page=wind_home-basics
- http://www1.eere.energy.gov/windandhydro
- http://www.awea.org/faq/wwt_basics.html
- http://www.birdnature.com/flyways.html

#3 Biomass

Biomass is the term used to describe the renewable-energy sources that come from plants and animals. Wood, animal waste, agricultural crops and urban waste (garbage) are all considered biomass. Biomass is converted into energy by burning it, fermenting it (turning it into alcohol), letting it decay or using chemicals to convert it into a gas or liquid (methane). Recently, trash is being burned to generate electricity. Imagine that – your local landfill might be a valuable energy resource in the near future! Biomass is probably the oldest source of energy used by humankind. And it is interesting to note that, despite the world's dependence on fossil fuels, biomass is the number one energy source used throughout the world. That might seem odd to Americans who rely heavily on coal and oil as energy sources, but many people worldwide use decaying wood and animal waste to heat their homes and cook their food.

Biodiesel

The fastest growing alternative-transportation fuel in the United States is biodiesel. This is a fuel made from vegetable oils, animal fats or greases. Most biodiesel fuels made today are from soybean oil, but corn is another plentiful source. In Montana sunflowers, safflower, canola, and camelina are crops grown to produce biodiesel. Camelina is especially promising because it has been used as fuel by both commercial and military jets and greatly reduces carbon emissions. Another interesting source for biodiesel is restaurant grease. When this fuel is used in an engine, the exhaust smells like French fries! Biodiesel has many advantages to traditional petroleum diesel. It is made from renewable sources and is less harmful to the environment. It burns cleaner, and if it is spilled, it breaks down in the environment. It even smells better than traditional diesel fuel. A big advantage is that biodiesel can be used in today's vehicles without any changes to the engines.

Ethanol is an alcohol fuel made by fermenting the natural sugars found in corn, wheat, potato waste, sawdust, urban waste and lawn clippings. Scientists continue to study ethanol production, experiments use enzymes to break down cellulose in woody fibers so that ethanol can be made from trees, grasses and crop waste. Research is even being conducted on oranges, using the fruit's peel and pulp, to produce ethanol.

- http://tonto.eia.doe.gov/kids/energy.cfm?page=biomass_home-basics
  http://www1.eere.energy.gov/biomass/pdfs/biofuels_for_your_state.pdf
- http://bozemandailychronicle.com/articles/2009/09/10/news/40navy.txt

#4 Geothermal

The term geothermal comes from the Greek geo, meaning earth, and therine, meaning heat, thus geothermal energy is energy derived from the natural heat of the earth. The earth's temperature varies widely, and geothermal energy is usable for a wide range of temperatures from room temperature to well over 300°F. For commercial use, a geothermal reservoir capable of providing hydrothermal (hot water and steam) resources is necessary. Geothermal reservoirs are generally classified as being either low temperature (<150°C) or high temperature (>150°C). Generally speaking, the high temperature reservoirs are the ones suitable for, and sought out for, commercial production of electricity. Geothermal reservoirs are found in "geothermal systems," which are regionally localized geologic settings where the earth's naturally occurring heat flow is near enough to the earth's surface to bring steam or hot water, to the surface.

- Geothermal energy from heat inside the Earth
  http://tonto.eia.doe.gov/kids/energy.cfm?page=geothermal_home-basics

#5 Hydropower

Hydropower is energy from water sources such as the ocean, rivers and waterfalls. Because the source of hydropower is water, hydroelectric power plants must be located on a water source. Electricity is produced by directing or channeling moving water to power electric generators. The flow or fall of the moving water determines the amount of energy available. There is a new technology on the horizon called Microhydro. It uses smaller water flows such as water flowing out of abandoned mines to run small generators. These small generators can then power equipment on remote sites to help treat the pollution in the abandoned mine water flow.

- http://tonto.eia.doe.gov/kids/energy.cfm?page=hydropower_home-basics
- http://www1.eere.energy.gov/windandhydro/

Activity 2: Now that students have more information on their renewable energy sources they will investigate their alternative energy source as it relates to Montana. Students will visit the following websites relating information on renewable energy in Montana, and the third key term: the ability to access alternative energy source in Montana. *Group will keep all of their information on renewable resources and the three key terms to use in the next lesson.*

Topic 3, Worksheet Links 2
Linking renewable energy to Montana

Wind

http://business.mt.gov/wind.asp
http://www.montanagreenpower.com/wind/mt_maps.php
http://www.windmap.org/windmaps/windmaps.asp
http://www.awea.org/newsroom/pdf/Top_20_States_with_Wind_Energy_Potential.pdf
http://www.solar-estimate.org/index.php

Solar and Hydrogen
http://www.montanagreenpower.com/solar/index.php
http://www.solar-estimate.org/index.php

Geothermal – this doesn't only mean hot springs, check out both sites
http://www.montanagreenpower.com/other/geothermal.php
http://www.montanagreenpower.com/other/geothermalheatpump.php
http://www.deq.state.mt.us/energy/geothermal/sites.asp

Hydropower
http://business.mt.gov/hydropower.asp
http://www.montanagreenpower.com/other/hydropower.php#hydropower
http://nris.mt.gov/gis/gisdatalib/downloads/dams.pdf

Biomass
http://www.usna.usda.gov/Gardens/collections/VirtualTours/USNA_PowerPlants_Flash.html
(which ones of these plant sources would be viable in Montana?)
http://www.montanagreenpower.com/bio/biomass.php
http://www.montanagreenpower.com/bio/index.php
http://www.billingsgazette.com/news/state-and-regional/montana/article_ff6a75d6-a410- 11de-bebb-001cc4c002e0.html

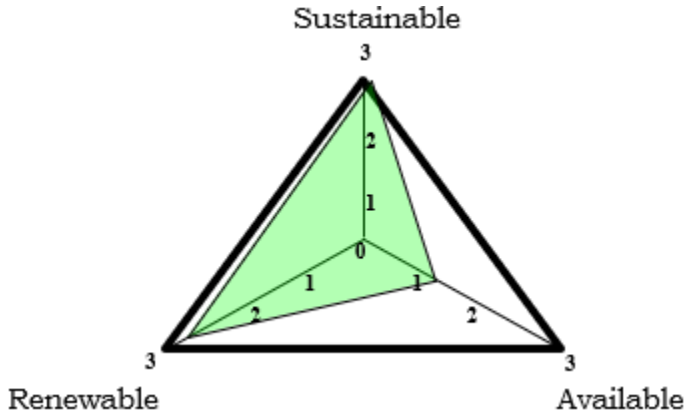
Notes:

Lesson 4: Topic 4 Investigating our findings

Prep: Make 10 copies of Topic 4: Worksheet 1 to hand out to each group. (Have students set one set of the copies aside to be used later.) Using the same worksheet as a guide and using sidewalk chalk, draw one large Decision Triangle Grid on an outdoor concrete surface. If you don't have access to an outdoor space for this activity, use an overhead projector with a transparency and project the image on your floor and mark out the lines and numerals with masking tape, and you can make cards with the key terms to tape down by each corner. The triangle should be about 3' long on each side. Make sure to make all of the marks on the inside of the triangle, and to label each corner!

Activity 1: Students will review their data from Activity 3.1 and 3.2. Have each group discuss their alternative energy source and write down their reasons for choosing each of the 3 options (sustainability, renewability, and availability) on the handout in area indicated.
Now students will have to assign a rating numeral as directed by the guide on the top of their worksheet. After all groups have finished their entire rating process have the group fill in the triangle at the bottom of the worksheet with the corresponding ratings and shade in the area between points.

Example: Geothermal energy may be viewed as being renewable, sustainable, but not necessarily available in all parts of Montana. *Try other terms as well in your lessons such as affordable, regionally available, etc.*

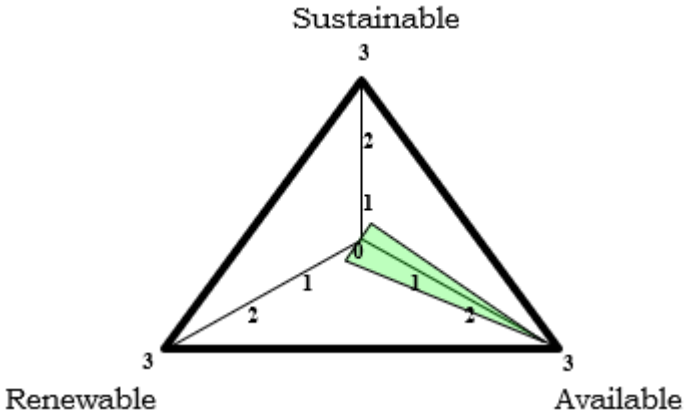


Once all groups have mapped their findings on the triangle, have some members of the group stand on the sidewalk or floor on the corresponding points from their worksheets and have them explain their decisions. Have groups inquire about each others decisions, groups should be allowed to change their ratings if they find information from other groups applicable. Students should consider that all forms of renewable energy can work together to fill energy needs, in Montana and across the world.

COMPARE AND CONTRAST FOR BEST PRACTICES

Assign each group to retrieve their extra copy of triangle triage worksheet. Using the knowledge gained on nonrenewable energy, have the students answer and rate the same key terms.
Compare the two triangles, what conclusions can be drawn?

Example: Coal in Montana



Lesson 5: Experiment with alternative energy – Labs and Lesson Plans

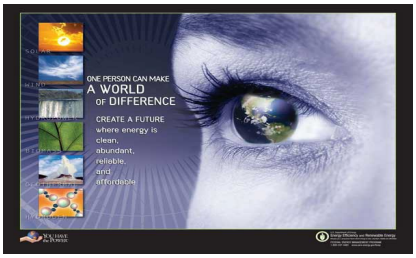
Above: Students build greenhouse with recycled plastic bottles.

For more innovative ideas on student projects visit the websites below:
http://www1.eere.energy.gov/biomass/pdfs/highschool_projects.pdf
http://www.uwsp.edu/cnr/wcee/keep/Resources/Internet_Links/Links_for_students.html
http://www.sciencebuddies.org/science-fair-projects/Intro-Energy-Power.shtml

Interactive Energy Calculator –Kilowatt hour equivalency to firewood, fast foods, coal and more! Try the link below so start your inquiry.

http://www.wattsonschools.com/calc-chem.htm

Lesson 6: Topic 4 Investigating my future, exciting careers in energy.



Job Opportunities
There are a wide variety of professions available in the renewable energy industry. This fact can make it challenging to find the right professional niche, but it also provides the opportunity for individuals with many different types and degrees of training to get involved with renewable energy. Some jobs—such as those in communications, community outreach, sales/marketing, and business support (e.g., corporate planning and finance, accounting, human resources, law, and information technology)— can be found in almost every renewable energy field. Other jobs are specific to individual renewable energy technologies, as shown in the following discussion of the five main renewable energy power sources: wind, solar, bioenergy (biomass), geothermal, and hydropower

Websites for careers in renewable energy!
http://www.nrel.gov/docs/fy01osti/28369.pdf
http://www.sciencemaster.com/jump/physical/careers_energy.php

Jobs in Bioenergy

Universities, national laboratories, and industry are working together to find solutions to the difficult problems surrounding the production and use of biomass for energy and products. These R&D efforts require chemists, agricultural specialists, microbiologists, biochemists, and engineers, just to name a few. Biofuel, biopower, and biobased product plants are most cost-effective when located near their source of biomass. Thus, bioenergy industry development has a special appeal because it creates direct and indirect jobs in rural areas of the country, and may prove to be a profitable complement for many existing agricultural and forestry businesses. Engineers and construction workers are needed to design and build bioenergy plants, while electrical/electronic and mechanical technicians, engineers mechanical, electrical, and chemical), mechanics, and equipment operators are needed to run and maintain these plants. Some may even require individuals cross trained in areas such as engineering and biology, or chemistry and agriculture. Jobs in bioenergy today cut across a wide spectrum of specialties and skills. And if R&D and industrial efforts succeed in making bioenergy more commercially profitable, we may see a dramatic increase in the number of bioenergy-related jobs. We'll need more farmers and foresters to produce and harvest biomass resources, more truckers to transport the resources to the power and fuel plants, and more operators to run facilities.

Jobs in Wind Power

People have been using energy from the wind for hundreds of years.

The wind industry employs both professional and skilled workers in a number of different capacities. New wind projects require people with business, meteorological, and engineering experience to plan and build projects. Meteorologists help engineers identify appropriate sites with suitable wind conditions. Engineers then design the wind plant, working with the utility companies and communities. Construction workers are needed to build the wind plant. And mechanical and electrical technicians, called "windsmiths," are required to operate and maintain the wind turbines..

Jobs in Hydropower

As with many of the other renewable energy technologies, the design, construction, and maintenance of hydropower plants requires electrical and mechanical engineers, technicians, and skilled workers. If the hydropower project also involves managing the reservoir and the surrounding land, the developer will also hire recreation planners, resource managers, and educators. In addition, state and federal licensing laws now require current or prospective hydropower plant developers to assess the environmental effects of their operation. Thus, the hydropower industry now also employs environmental scientists (biologists, hydrologists, ecologists, and wildlife habitat specialists, for example) to assess environmental impacts and address environmental remediation. Environmental scientists, as well as engineers, also

participate in R&D (research and development) efforts through private companies, national laboratories, and universities.

Jobs in Solar Power

Anyone who has visited Florida in July knows that the sun can produce heat. Andin 1839, French physicist Edmund Bequerel discovered that sunlight could also produce electricity (known as the photoelectric effect). Knowledge of the sun's ability to produce both heat and electricity has led to the invention of numerous technologies for capturing the sun's energy. Growth of the solar power industry creates high-wage, skilled jobs throughout the country for individuals with many different types of training. R&D groups at national laboratories, universities, and private companies develop and continually improve solar products to lower their costs and improve their reliability. Individuals employed in solar R&D generally have professional degrees in electrical, mechanical, and chemical engineering; materials science, and/or physics.

Jobs in Geothermal Energy

The geothermal industry employs both skilled workers and those with professional degrees. Developing hot water reservoirs requires geologists, geochemists, geophysicists, hydrologists, reservoir engineers, mud loggers, hydraulic engineers, and drillers to locate, assess, and access the reservoirs. Environmental scientists prepare environmental impact studies, and permit and leasing specialists obtain the land rights. Geothermal direct- use technologies create obs for heating engineers, and in the building and agricultural industries. For electricity production, engineers (electrical and mechanical) and construction workers— along with electrical technicians, electricians, electrical machinists, welders, riggers, and mechanics—are needed to design and construct power plants. Mechanical engineers, geologists, drilling crews, and heating, ventilation, and air conditioning.

WORKSHEET SECTION

Day 1, Activity 1A
(2 pages) (Make 10 copies)

Ban Dihydrogen Monoxide!

The Invisible Killer

Dihydrogen monoxide is colorless, odorless, tasteless, and kills uncounted thousands of people every year. Most of these deaths are caused by accidental inhalation of DHMO, but the dangers of dihydrogen monoxide do not end there. Prolonged exposure to its solid form causes severe tissue damage. Symptoms of DHMO ingestion can include excessive sweating and urination, and possibly a bloated feeling, nausea, vomiting and body electrolyte imbalance. For those who have become dependent, DHMO withdrawal means certain death.

 **Dihydrogen monoxide:**

- is also known as hydroxyl acid, and is the major component of acid rain.
- contributes to the "greenhouse effect."
- may cause severe burns.
- contributes to the erosion of our natural landscape.
- accelerates corrosion and rusting of many metals.
- may cause electrical failures and decreased effectiveness of automobile brakes.
- has been found in excised tumors of terminal cancer patients.

 **Contamination Is Reaching Epidemic Proportions!**

Quantities of dihydrogen monoxide have been found in almost every stream, lake, and reservoir in America today. But the pollution is global, and the contaminant has even been found in Antarctic ice. DHMO has caused millions of dollars of property damage in the midwest, and recently California.

 Despite the danger, dihydrogen monoxide is often used:

- as an industrial solvent and coolant.
- in nuclear power plants.
- in the production of styrofoam.
- as a fire retardant.
- in many forms of cruel animal research.
- in the distribution of pesticides. Even after washing, produce remains contaminated by this chemical.
- as an additive in certain "junk-foods" and other food products.

Companies dump waste DHMO into rivers and the ocean, and nothing can be done to stop them because this practice is still legal. The impact on wildlife is extreme, and we cannot afford to ignore it any longer!

 **The Horror Must Be Stopped!**

The American government has refused to ban the production, distribution, or use of this damaging chemical due to its "importance to the economic health of this nation." In fact, the navy and other military organizations are conducting experiments with DHMO, and designing multi-billion dollar devices to control and utilize it during warfare situations. Hundreds of military research facilities receive tons of it through a highly sophisticated underground distribution network. Many store large quantities for later use.

It's Not Too Late!

Act NOW to prevent further contamination. Find out more about this dangerous chemical. What you don't know can hurt you and others throughout the world.

Visit DHMO Central

Topic 4: Worksheet1
Triangle Triage – Student Sheet

Group Name: _____ Date: _____

Directions: Complete the decision grid for the topic discussed in class today.

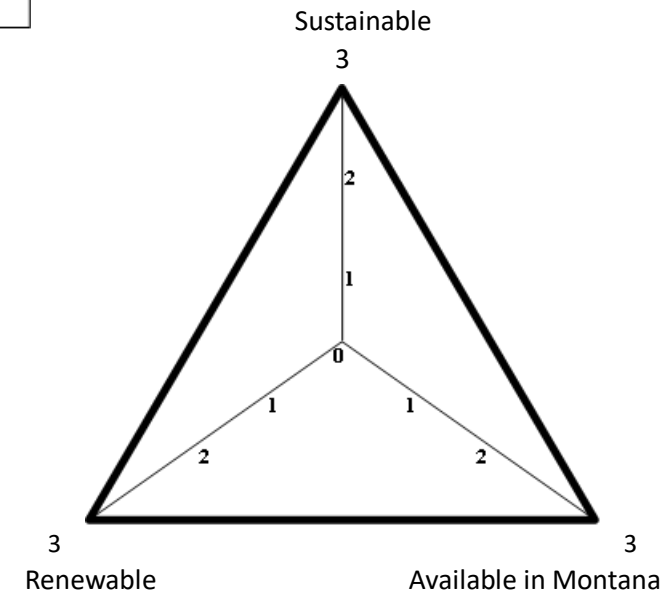
Rating Scale:

3 - Meets all, or nearly all of the criterion of section 2 - Meets most of the criterion
1 - Meets some of the criterion
0 - Meets little, if any of the criterion

Topic: Renewable Energy

Sustainable	
Criteria	**Ratings**
Is the energy source renewable?	
List reasons here:	
AVERAGE RATING:	
Renewable	
Is the energy source renewable?	
List reasons here:	
AVERAGE RATING:	
Available	
Is the energy source renewable?	
List reasons here:	
AVERAGE RATING:	

Area of Triangle
A= b x h



Used with permission of the Keystone Center

Additional Resources

Helpful Internet sites for climate status http://epa.gov/climatechange/effects/agriculture.html
Helpful Internet sites for energy unit conversion:
http://tonto.eia.doe.gov/kids/energy.cfm?page=about_energy_conversion_calculator-basics#eleccalc
http://www.iea.org/Textbase/stats/unit.asp
Helpful Internet sites used for weather data: http://weather.msn.com/
http://weather.weatherbug.com
www.accuweather.com
www.noaa.gov
www.weatherunderground.com
www.weatehr.com

ENERGY TERMS

Annual Consumption – Annual consumption refers to the amount of electricity used in one year and is typically measured in kilowatt-hours (kWh). This information is available on your electricity bill or by contacting your energy provider.

Anthropogenic – Caused by man or resulting from human activities. Used in the context of greenhouse gas emissions produced as a result of human activities.

Atmosphere – The gaseous envelope surrounding the Earth. The dry atmosphere consists almost entirely of nitrogen (78.1% volume mixing ratio) and oxygen (20.9% volume mixing ratio), together with a number of trace gases, such as argon (0.93% volume mixing ratio), helium, radiatively active greenhouse gases such as carbon dioxide (0.035% volume mixing ratio), and ozone. In addition the atmosphere contains water vapor, whose amount is highly variable but typically 1% volume mixing ratio. The atmosphere also contains clouds and aerosols.

Atmospheric Lifetime – The lifetime of a greenhouse gas refers to the approximate amount of time it would take for the anthropogenic increment to an atmospheric pollutant concentration to return to its natural level (assuming emissions cease) as a result of either being converted to another chemical compound or being taken out of the atmosphere via a sink. This time depends on the pollutant's sources and sinks as well as its reactivity. The lifetime of a pollutant is often considered in conjunction with the mixing of pollutants in the atmosphere; a long lifetime will allow the pollutant to mix throughout the atmosphere. Average lifetimes can vary from about a week (e.g., sulfate aerosols) to more than a century (e.g., chlorofluorocarbons [CFCs], carbon dioxide).

Carbon Dioxide – Carbon dioxide (CO_2) is an atmospheric gas that is a major component of the carbon cycle. Although produced through natural processes, carbon dioxide is also released through human activities, such as the combustion of fossil fuels to produce electricity. Carbon dioxide is the predominate gas contributing to the greenhouse effect, and as such is known to contribute to climate change.

Carbon Intensity – The amount of carbon by weight emitted per unit of energy consumed. A common measure of carbon intensity is weight of carbon per British thermal unit (Btu) of energy. When there is only one fossil fuel under consideration, the carbon intensity and the emissions coefficient are identical. When there are several fuels, carbon intensity is based on their combined emissions coefficients weighted by their energy consumption levels.1

Certification and Verification – Refers to the certification and verification of green power products. See the *Certified and Verified Products* section of this Web site for more information.

Climate – Climate in a narrow sense is usually defined as the "average weather," or more rigorously, as the statistical description in terms of the mean and variability of relevant quantities over a period of time ranging from months to thousands of years. The classical period is three decades, as defined by the World Meteorological Organization (WMO). These quantities are most often surface variables such as temperature, precipitation, and wind. Climate in a wider sense is the state, including a statistical description, of the climate system.

Combined Heat and Power – Combined heat and power (CHP), also known as cogeneration, is an efficient, clean, and reliable approach to generating power and thermal energy from a single fuel source. CHP is not a specific technology but an application of technologies to meet an energy user's needs. CHP systems achieve typical effective electric efficiencies of 50 to 80 percent — a dramatic improvement over the average efficiency of separate heat and power. Since CHP is highly efficient, it reduces traditional air pollutants and carbon dioxide, the leading greenhouse gas associated with climate change. Visit EPA's *Combined Heat and Power Partnership* Web site for additional information

Commodity Electricity – Is physical electricity in the absence of the technological, environmental, social, and economic benefits associated with a specific generation source. These benefits are transferable over geographic distance through a tradable instrument called a renewable energy certificate (REC) and can be re-associated with the physical electricity at the point of use.

Competitive Markets – Until recently, most consumers received generation, transmission, and distribution services from one local utility company. As a regulated monopoly, the utility was given an exclusive franchise to provide electricity to consumers in any particular community. Rates were set, and consumers had little choice but to pay that rate. In recent years, however, many states have restructured their electricity industry and are now allowing consumers to choose from among competing electricity suppliers.

In these states with retail competition, sellers of electricity obtain power by contracting with various generation sources and setting their own price. Consumers in these states have the opportunity to choose their energy provider and purchase products based on the price or type of power supplied to their home or business. Some consumers are exercising this choice and switching to accredited "green power" resources. In states that have not restructured their electricity markets, consumers interested in purchasing renewable energy now have the option to participate in green pricing programs offered by their local utility.

Conventional Power – Power that is produced from non-renewable fuels, such as coal, oil, natural gas, and nuclear. Conventional fuels are finite resources that cannot be replenished once they are extracted and used.

Distributed Generation – Small, modular, decentralized, grid-connected or off-grid energy systems located in or near the place where energy is used.

Electricity Supplier – As states restructure their electricity markets, an increasing number of customers will be able to choose from a range of electricity suppliers who market different types of power products, including green power. In states without restructured electricity markets, local utilities may offer green pricing programs that enable customers to elect to have their utility generate a portion of their power from renewable sources. To find out about green power products in your area, visit the *Green Power Locator*.

Emissions – The release of a substance (usually a gas when referring to the subject of climate change) into the atmosphere.

Energy Efficiency – Refers to products or systems using less energy to do the same or better job than conventional products or systems. Energy efficiency saves energy, saves money on utility bills, and helps protect the environment by reducing the demand for electricity. When buying or replacing products or appliances for your home, look for the ENERGY STAR® label — the national symbol for energy efficiency. For more information on ENERGY STAR-labeled products, visit the *ENERGY STAR Web site*.

Energy Marketers – See Electricity Supplier.

Executive Order 13423: Strengthening Federal Environmental, Energy and Transportation Management – *Executive Order 13423* calls for Federal agencies sets goals in the areas of energy efficiency, acquisition, renewable energy, toxics reductions, recycling, sustainable buildings, electronics stewardship, fleets, and water conservation.

Fossil Fuels – Fossil fuels are the nation's principal source of electricity. Fossil fuels come in three major forms: coal, oil, and natural gas. Because fossil fuels are a finite resource and cannot be replenished once they are extracted and burned, they are not considered renewable.

Generation – The act of transforming energy into electricity.

Global Climate Change – Climate change refers to any significant change in measures of climate (such as temperature, precipitation, or wind) lasting for an extended period (decades or longer).
Climate change may result from:

- Natural factors, such as changes in the sun's intensity or slow changes in the Earth's orbit around the sun
- Natural processes within the climate system (e.g. ,changes in ocean circulation)

- Human activities that change the atmosphere's composition (e.g., through burning fossil fuels) and the land surface (e.g., deforestation, reforestation, urbanization, desertification)

Global Warming Potential (GWP) – Global Warming Potential (GWP) is defined as the cumulative radiative forcing effects of a gas over a specified time horizon resulting from the emission of a unit mass of gas relative to a reference gas. The GWP-weighted emissions of direct greenhouse gases in the U.S. Inventory are presented in terms of equivalent emissions of carbon dioxide (CO2), using units of teragrams of carbon dioxide equivalents (Tg CO2 Eq.).

Conversion: Tg = 109 kg = 106 metric tons = 1 million metric tons

The molecular weight of carbon is 12, and the molecular weight of oxygen is 16; therefore, the molecular weight of CO2 is 44 (i.e., 12+[16 x 2]), as compared to 12 for carbon alone. Thus, carbon comprises 12/44ths of carbon dioxide by weight.

Greenhouse Gases (GHGs) – Gases in the Earth's atmosphere that produce the greenhouse effect. Changes in the concentration of certain greenhouse gases, due to human activity such as fossil fuel burning, increase the risk of global climate change. Greenhouse gases include water vapor, carbon dioxide, methane, nitrous oxide, halogenated fluorocarbons, ozone, perfluorinated carbons, and hydro fluorocarbons.

Green Power – Renewable energy resources such as solar, wind, geothermal, biogas, biomass, and low-impact hydro generate green power. A green power resource produces electricity with zero anthropogenic (i.e., human-caused) emissions, has a superior environmental profile to conventional power generation, and must have been built after the beginning of the voluntary market (1/1/1997).

Green Power Marketers – Due to increased customer awareness of the environmental implications associated with conventional power generation, a growing number of utilities and other types of energy service providers have begun offering green power products. The term "green power marketers" usually refers to energy providers operating in states that permit retail competition in the electricity markets. In states that do not allow this retail competition, many utilities have begun offering green power options under what are typically referred to as green pricing programs. To learn more about green power products in your area and whether your utility offers a green pricing program, visit the *Green Power Locator*.

Green Power Product – Green power electricity products are supplied from renewable energy resources that provide the highest environmental benefit. Green power sold by regulated utilities is called green pricing, and when sold in competitive electric markets, green power is called green marketing.

Green Pricing – Some power companies are now providing an optional service, called green pricing, which allows customers to pay a small premium in exchange for electricity generated from green power resources. The premium covers the increased costs incurred by the power provider (i.e., the electric utility) when adding green power to its power generation mix. To find out if your utility offers a green pricing program, refer to the *Green Power Locator*.

Green Power Purchasing – Green power can be purchased nationwide from several sources. Green power marketers offer green power products to consumers in deregulated markets, such as New Jersey, Pennsylvania, and New England. In states that do not allow retail competition in the electricity markets, many utilities offer green power products through green pricing programs. In addition, all customers nationwide have the opportunity to buy green power and stimulate the development of renewable generation sources through renewable energy certificates. Finally, customers can choose to install on-site generation, such as solar photovoltaics.

Hydroelectric Power (Large) – The process of generating electricity by harnessing the power of moving water is called hydroelectricity. Hydroelectric power (hydropower) is generated by forcing water that is flowing downstream, often from behind a dam, through a hydraulic turbine that is connected to a generator. The water exits the turbine and is returned to the stream or riverbed. Much of the hydroelectricity in the United States is generated at large facilities and in the Pacific Northwest, where it meets about two-thirds of the electricity demand. In the United States, hydroelectricity contributes about 10 percent of the total electricity supply.

Hydro (Small-scale) – In addition to very large hydroelectric plants in the West, the United States also has many smaller hydroelectric facilities. Like large plants, small-scale hydroelectric systems capture the energy in naturally flowing water and convert it to electricity. Although the potential for small hydroelectric systems depends on the availability of suitable water flow, these systems can provide cheap, clean, reliable electricity where the resource exists.

Kilowatt-hour – A kilowatt-hour (kWh) is a standard metric unit of measurement for electricity.

- One kilowatt-hour (kW) is equal to 1,000 watt-hours (Wh).
- A watt-hour is the amount of energy delivered at a rate of one watt (W) for a period of one hour.
- One watt is the amount of power rate of one joule of work per second of time.
- Example: A 100 watt light bulb in use for 10 hours uses 1000 watt-hours, or 1 kilowatt of electricity. (100 watts x 10 hours = 1000 watt-hours = 1 kWh)

Megawatt-hour – A megawatt-hour (MWh) is equal to 1,000 kWh.

Methane (CH4) – A hydrocarbon that is a greenhouse gas with a global warming potential most recently estimated at 23 times that of carbon dioxide (CO2). Methane is produced through anaerobic (without oxygen) decomposition of waste in landfills, animal digestion, decomposition of animal wastes, production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion. The global warming potential (GWP) is from the Intergovernmental Panel on Climate Change's (IPCC's) Third Assessment Report (TAR).

Metric Ton – Common international measurement for the quantity of greenhouse gas emissions. A metric ton is equal to 2205 lbs or 1.1 short tons.

Net Metering – A method of crediting customers for electricity that the customer generates on site in excess of their own electricity consumption. Customers with their own generation offset the electricity they would have purchased from their utility. If such customers generate more than they use in a billing period, their electric meter turns backwards to indicate their net excess generation. Depending on individual state or utility rules, the net excess generation may be credited to their account (in many cases at the retail price), carried over to a future billing period, or ignored.

"New" Renewables – The voluntary green power market came into existence in the late 1990's. January 1, 1997 is considered a definitive point in time when green power facilities could be adequately identified as having been developed to serve the green power marketplace. Green power facilities placed into service after January 1, 1997 are said to produce "new" renewable energy. The "new" criterion addresses the additionality requirement for the voluntary market.

Nitrogen Oxides (NOX) – Gases consisting of one molecule of nitrogen and varying numbers of oxygen molecules. Nitrogen oxides are produced in the emissions of vehicle exhausts and from power stations. In the atmosphere, nitrogen oxides can contribute to formation of photochemical ozone (smog), can impair visibility, and have health consequences; they are thus considered pollutants.

On-site Renewable Generation – Electricity generated by renewable resources using a system or device located at the site where the power is used. On-site generation is a form of distributed energy generation. For more information about distributed energy technologies that are renewable and non-renewable, visit the *Department of Energy's Distributed Energy Resources Web site*.

Renewable Energy – The term renewable energy generally refers to electricity supplied from renewable energy sources, such as wind and solar power, geothermal, hydropower, and various forms of biomass. These energy sources are considered renewable sources because their fuel sources are continuously replenished. Some renewable energy resources, such as nuclear power, have environmental impacts that preclude their acceptance among customers in the voluntary green power market.

Renewable Energy Resources – See *Green Power Market* section of this Web site.

Renewable Energy Certificates (RECs) – Also known as green tags, green energy certificates, or tradable renewable certificates. RECs represent the technology and environmental attributes of electricity generated from renewable sources. RECs are usually sold in 1 megawatt-hour (MWh) units. A certificate can be sold separately from the underlying generic electricity with which it is associated. Once the REC is sold separately from the underlying electricity, the electricity is no longer considered renewable. RECs provide buyers flexibility to offset a percentage of their annual electricity use when green power products may not be available locally.

Renewable Portfolio Standard – The requirement that an electric power provider generate or purchase a specified percentage of the power it supplies/sells from renewable energy resources, and thereby guarantee a market for electricity generated from renewable energy resources.

Retail Competition – In states with retail competition, consumers have the opportunity to choose their energy provider and purchase products based on the price or on the source of power supplied to their home or business.

Short Ton – Common measurement for a ton in the United States. A short ton is equal to 2,000 lbs or 0.907 metric tons. See metric ton.

Sulfur Dioxide – High concentrations of sulfur dioxide affect breathing and may aggravate existing respiratory and cardiovascular disease. Sensitive populations include asthmatics, individuals with bronchitis or emphysema, children, and the elderly. Sulfur dioxide is also a primary contributor to acid rain, which causes acidification of lakes and streams and can damage trees, crops, historic buildings, and statues. In addition, sulfur compounds in the air contribute to visibility impairment in large parts of the country. This is especially noticeable in national parks. Sulfur dioxide is released primarily from burning fuels that contain sulfur (such as coal, oil, and diesel fuel). Stationary sources such as coal- and oil-fired power plants, steel mills, refineries, pulp and paper mills, and nonferrous smelters are the largest releasers.

Utility – A utility is a municipal or private business that provides electricity to the public and is subject to governmental regulation.

Vintage – A term that refers to the year that purchased green power was generated. Refer to the *Green Power Partners Program Requirements* for more information.

Source: *EPA*