

Topic 7

Other Renewable Energy Sources



Topic 7: Other Renewables

Introduction

Wind energy is not the only renewable energy option available. Companies & individuals are also looking to biofuels, solar energy and geothermal energy as other renewable resources. The purpose of this section is to inform students about different areas of renewable energy and how they are used to produce electricity.

Biofuels

Oklahoma is charging into biofuels with the Oklahoma Bioenergy Center, which will focus on ethanol research and education. The center will be composed of researchers from Oklahoma State University, the University of Oklahoma, and the Noble Foundation. One of Oklahoma's prominent biomass resources is switchgrass. There is ongoing research on which type of switchgrass is the most efficient for biofuels, so that Oklahoma's farmers can start growing it for ethanol production.

Biofuels can be used as a fuel additives or in its pure forms to help reduce a vehicle's carbon monoxide and other smog-causing emissions. Biomass is the resource for biofuels; corn stalk, grain straw, paper pulp, municipal solid waste, and switchgrass are some examples of biomass.



Ethanol is an alcohol that is made by fermenting any biomass high in carbohydrates. There are two ways ethanol is produced, they are the wet milling and dry milling processes, the major difference between the two is how the grain is prepared before it is ground up. In this section we will focus on the process most used, the dry milling process. First, the starchy grain, usually corn, is ground into a “meal” and then water is added to make it a mush texture. Enzymes are then added to make the substance into a simple sugar. To reduce bacteria, the mashed up corn is cooked and cooled before moving to the fermentor.

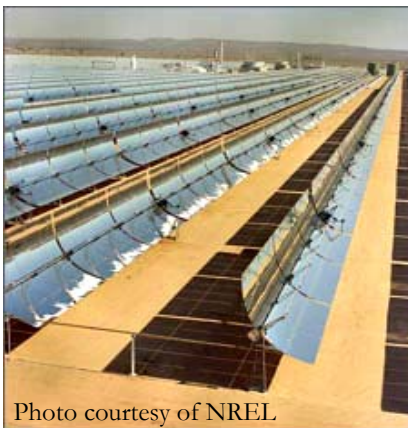
In the fermentation process, yeast is added and the sugar is converted to ethanol and carbon dioxide. The carbon dioxide released during this process is acquired and used for soft drinks and making dry ice. The process takes about 40 – 50 hours. Next the ethanol is filtered from the fermented mash in the distiller and dehydrated in a molecular sieve system. In order for the ethanol to avoid being subject to alcohol tax, 5% of a denaturant, like natural gasoline, is added to make it undrinkable. Finally the ethanol is ready to be shipped to retailers. The products left over from the ethanol production are evaporated and sent out as feed for livestock.

Biodiesel can be made using vegetable oils, animal fats, algae, and recycled cooking grease, though it is primarily made from soy beans. The oil being used for biodiesel production undergoes a chemical process called transesterification. This process breaks the oil down into glycerin that can be used in soaps and methyl esters, which is the biodiesel. Both products are refined and then shipped out to retailers.

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Solar Energy

Solar power is an energy source that can be used to make electricity. The Southwest U.S has the best solar resource because climate reports show that is the area that receives the most sunlight. There are many ways that solar power is used today. Power plants use solar power by concentrating it in different ways such as through parabolic-trough systems, dish/engine systems, and power towers. Passive solar systems are made of materials that absorb and store the sun's heat and slowly release at night, they are mainly used on buildings and houses. Photovoltaics (PV) consist of photovoltaic cells that convert sunlight into electricity, some calculators, for example, use a PV system. Solar hot water heaters use the sun to heat water instead of electricity. Solar Process Heat systems are for commercial or industrial buildings and are designed to provide large amounts of hot water and heating to the buildings. Here we will only focus on photovoltaic and solar concentrating systems.



Photovoltaic systems are the flat large panels you see sitting on top of a house, this is called a solar array. The array consists of the modules and the modules consists of PV cells. A PV cell is made up of two layers of semiconductors made from silicon, one is negatively charged the other has a positive charge. As light hits the cell, electrons are set free and move from the cells' negative layer to the positive layer. The flow of the electrons creates a current for electricity. The process for concentrating solar power can be done in three different ways. One is through parabolic-trough systems which uses curved mirrors to focus sunlight on a pipe running through the troughs. In the pipe is oil that is heated and is used to boil water that provides steam for the steam generator to produce

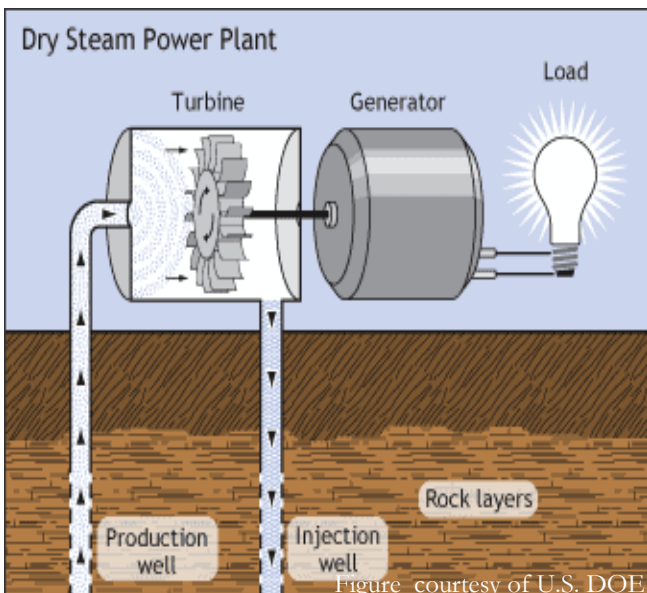
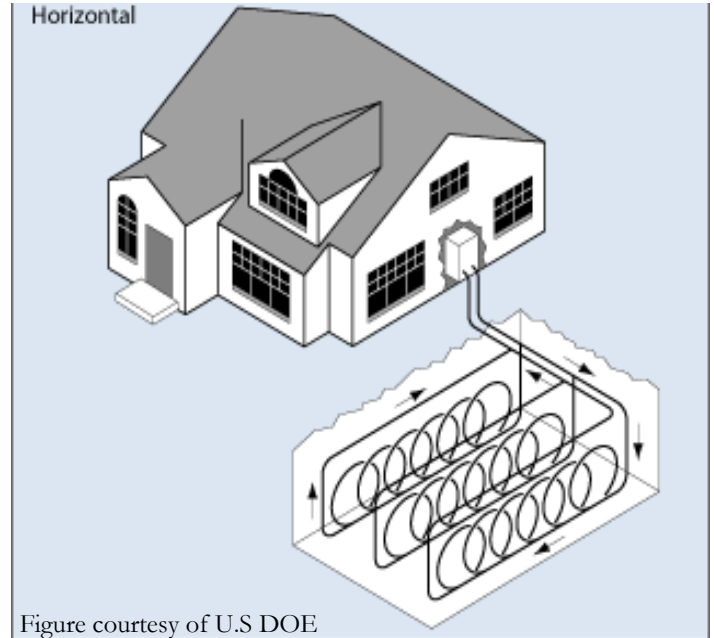
electricity. The second way is through a dish/engine system, which is where a mirrored dish reflects the sun's heat to a receiver. The receiver collects the heat and transfers it to a fluid, the fluid expands due to the heating and is used to drive a turbine. The turbine runs a generator to produce electricity. The third way is a power tower, it is similar to a dish/engine system, but instead of a mirrored dish there is a field of mirrors and the receiver which sits on a tower. The sunlight is concentrated on the receiver that contains molten salt, the salt is heated and flows through the receiver. The heat from the salt is used on a conventional steam generator to produce electricity. The advantage to using molten salt is that it stores the heat for days so electricity can be produced on cloudy days or after sunset. To see an animation or for more information please refer to the reference page.

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Geothermal Energy

Geothermal energy uses geothermal fluid, very hot water, or steam, from under the earth's surface to power generators that produce electricity. The geothermal process involves drilling deep into the earth's crust and releasing the heat as either steam or hot water and using a fuel generator that produces electricity. Geothermal energy is most prominent in the western U.S.

Residences, commercial buildings, and power plants all use different types of geothermal energy. Heat pump systems, (see the figure to the left), are mainly used for residence and commercial buildings. Heat pumps systems use pipes buried underground that take in heat, the heat then goes through the heat exchanger and distributes it through out the building in the winter. In the summer the process is reversed, the system takes the heat out of the building and transfers it into the ground.



Geothermal power plants drill about a mile deep to access hot water and steam to fuel the generators to make electricity. There are three types of power plants today, (the figures to the right display how each power plant works). The first is a dry steam plant that directly uses the steam from under the earth's surface to power the turbine that powers the generator.

Second is a flash steam power plant, where hot hydrothermal fluids are sprayed into a low pressure tank, and the fluid vaporizes so quickly, that it looks like a "flash". The vapor pushes the turbine that cranks the generator to produce electricity, liquid from the vapor drains from the turbine tank and is injected in the ground again to be reused.

Third is a binary cycle power plant, where two separate fluids are used. One fluid is heated by the geothermal fluid and vaporizes, pushing the turbine. The other fluid is a secondary working fluid that is cooled and condensed, and then heated again by the geothermal fluid. This process is repeated, creating a continuous cycle of energy production. The geothermal fluid is then injected back into the ground to be reused.

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The third type of geothermal plant is the binary cycle power plant, which is made for geothermal resources at moderate temperatures. It works the same as a flash steam power plant, except binary-cycle plants can utilize geothermal fluids at moderate temperatures. This is done by adding a secondary fluid that has a lower boiling point than water, and geothermal fluid then passes through a heat exchanger. The heat from the geothermal fluid causes the secondary fluid to vaporize quickly that moves the turbine, which in turn cranks the generator to produce electricity. In the future most geothermal power plants will be binary-cycle plants.



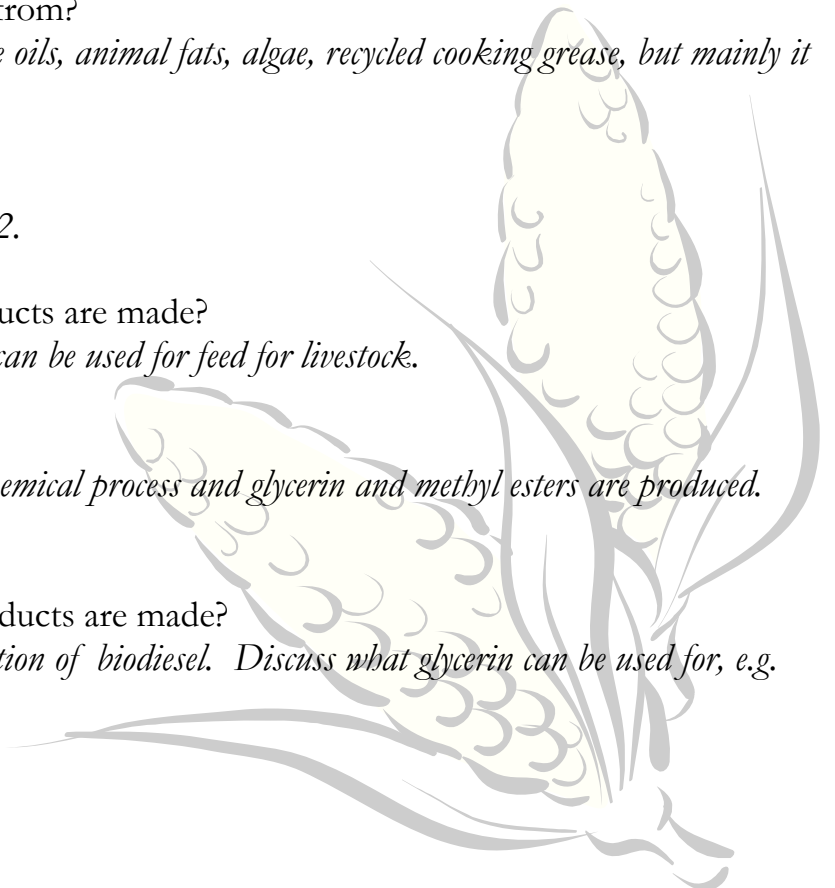
For visual aids or more information please see the reference page.

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Teacher Discussion Questions

Biofuels

- 1.) What are biofuels and how are they helpful to the environment?
 - a. *Biofuels are made from biomass and are used to help reduce vehicles carbon monoxide and other pollutants. The two most common biofuels are ethanol and biodiesel. Discuss different types of biomass.*
- 2.) Where is most of the resource for biofuels located and why?
 - a. *The majority of resources are located in the Midwest, this is where many crops are grown, i.e. the Corn Belt.*
- 3.) What resources can ethanol be produced from?
 - a. *Ethanol is produced from biomass high in carbohydrates, usually corn or sugarcane.*
- 4.) What resource can biodiesel be produced from?
 - a. *Biodiesel can be produced from Vegetable oils, animal fats, algae, recycled cooking grease, but mainly it is made from soy beans.*
- 5.) How is ethanol produced?
 - a. *Discuss the dry milling process on page 2.*
- 6.) When ethanol is made what other by products are made?
 - a. *The distiller's grain that is a byproduct can be used for feed for livestock.*
- 7.) How is biodiesel produced?
 - a. *The vegetable oil is broken down in a chemical process and glycerin and methyl esters are produced. Methyl esters are the biodiesel.*
- 8.) When biodiesel is made what other by products are made?
 - a. *Glycerin is a byproduct from the production of biodiesel. Discuss what glycerin can be used for, e.g. soap.*



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Teacher Discussion Questions

Solar

- 1.) What is solar energy and what makes it renewable?
 - a. *Solar energy utilizes sunlight to make electricity*
 - b. *It is renewable because its source is the sun.*
- 2.) Where is best solar energy resource in the United States?
 - a. *The best resources are in the Southwest*
- 3.) Why do you think the solar energy is most prominent there?
 - a. *This is an area that receives the most sunlight.*
- 4.) What are the different types of solar energy?
 - a. *There are many different types of solar energy. Briefly describe each of the following:*
 - i. *Solar Concentrating*
 - ii. *Passive Solar Systems*
 - iii. *Photovoltaics*
 - iv. *Solar Water Heater*
 - v. *Solar Process Heat Systems*
- 5.) What are the three processes that solar energy can be concentrated?
 - a. *The three processes are mentioned below, describe each:*
 - i. *Parabolic Trough System*
 - ii. *Dish/Engine System*
 - iii. *Power Tower*
- 6.) Which of the three processes has the biggest advantage?
 - a. *The power tower uses molten salt that can hold heat longer and allows for electricity to be produced on cloudy days.*
- 7.) How does a photovoltaic system work?
 - a. *A photovoltaic system has two layers of semiconductors, a positive layer and negative layer. The sunlight hits the cell and electrons are released and flow to the positive side creating a current.*
- 8.) Which types of solar energy are more appropriate for residences? Commercial use?
 - a. *Passive solar systems, photovoltaics, and solar hot water heaters for residential use.*
 - b. *Solar process heat systems for commercial use.*

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Teacher Discussion Questions

Geothermal Energy

- 1.) What is geothermal energy and how does it help the environment?
 - a. *Geothermal energy utilizes geothermal fluid as an energy source to produce electricity, and it does not require burning fossil fuels.*
- 2.) Where is the best geothermal resource in the United States?
 - a. *The best geothermal resources are located in the western United States.*
- 3.) How does a heat pump system work and where are they used?
 - a. *A heat pump system takes heat from shallow underground pipes into the building to the heat exchanger, where the heat is transferred to the rest of the building.*
 - b. *Heat pumps are mainly used in houses and commercial buildings.*
- 4.) How does a geothermal power plant work?
 - a. *It vaporizes the hydrothermal fluid to power the turbine that drives the generator; the generator produces electricity.*
- 5.) What are the different types of geothermal power plants?
 - a. *Briefly discuss the differences in each:*
 - i. *Dry Steam Power Plant*
 - ii. *Flash Steam Power Plant - uses a flash tank*
 - iii. *Binary Cycle Plant - uses a heat exchanger*
- 6.) Which geothermal plant is most commonly used?
 - a. *The binary cycle plant; it can be used at moderate geothermal temperatures that covers more area.*

