**Renewable and Alternative Energy Sources**

**-U.S Energy Consumption**

    The four primary consumers of energy in the U.S. in 2007 were

        Industrial 32%, Transportation 28%, Residential 22%, Commercial 18%

93% of the energy generated and used in the U.S. are from nonrenewable resources

**-Alternative Energy Source**

    World-wide, with the exception of coal, which has known reserves that will last a couple of centuries, the known reserves of oil are expected to be exhausted in your lifetime... Clearly, alternative energy sources are needed for the future

**-Solar Energy**

    The Sun is free (nobody owns or controls it). In principle, the amount of solar energy that reaches the Earth’s surface could provide for all human energy needs forever

    The distribution of solar energy over the continental U.S. in watts per square meter. The desert regions of the southwest U.S. receive the most sunlight

**-Clean Solar Energy**

    Solar energy is clean energy. It produces no hazardous solid, liquid or gas wastes. It does not create water or air pollution

**-Solar Energy (2)**

    The two areas in which solar energy can make the greatest contribution are in space heating and in the generation of electricity. These are uses that account for two-thirds of U.S. energy consumption

**-Solar Heating**

    The simplest approach to solar heating is passive-solar heating. The building design should allow the maximum amount of sunlight to stream in through south and west windows during the cooler months. This heats the house and materials inside.

    Trees can be positioned to shade the house in summer. Wide eaves can shade windows in summer, but allow winter sunlight to enter. Drapes and shutters can insulate window areas in winter.

    It has been estimated that 40 to 90% of most homes’ heating requirements could be supplied by passive-solar heating systems. 100% solar homes have been built, but such homes usually cost many tens of thousands of dollars more to build.

    Retrofitting older homes to be solar efficient can be too costly. Over insulation can aggravate indoor pollution

**-Solar Electricity**

    Direct production of electricity using sunlight is accomplished using photovoltaic cells, also called solar cells. They have no moving parts and are “clean” energy.

    They are used to power the space station and to provide electricity in remote areas on Earth.

    A major limitation is cost, which greatly exceeds the cost of producing electricity using fossil fuels or nuclear power. The best solar cells are only 20% efficient and only provide 50 watts of electricity per square meter of cell size.

    A 100 watt light bulb would require 2 square meters of solar cells and a 100-megawatt power plant would require 2 square kilometers (0.78 square miles) of solar cells.

**-Storing Solar Energy**

    In a solar energy home, extra electricity is stored in batteries for later use. This work well for one house. Unfortunately, no wholly practical technology has been developed to store large amounts of electricity, despite advances in batteries.

    Some possible schemes for storing the energy of solar generated electricity include breaking up water into oxygen and hydrogen to burn later as fuels. Also pumping water to an elevated reservoir for later use as hydroelectric power generation.

**-Geothermal Power**

    Magma rising from the mantles brings unusually hot material near the surface. Heat from the magma, in turn, heats any groundwater. This is the basis for generating geothermal energy. The steam and/or hot water is used to create electricity or for heating

**-Geothermal Power Plants**

Worldwide, there are now about 40 geothermal power plants, especially in Japan, Mexico and the Philippines. Note that most geothermal power plants are built along plate tectonic boundaries.

    How the geothermal energy is used depends on the temperature of the water. Three types of power plants are used to generate power from geothermal energy: Dry steam, Flash, Binary.

**-Types of Geothermal Power**

    Dry steam plants take steam out of the ground and uses the steam to turn a turbine that spins a generator. This was first done in Italy in 1904. Iceland, a volcanic island, has many geothermal areas that produce steam and are tapped to generate electricity.

    Flash plants take super-heated water, usually at temperatures over 200°C, out of the ground, allowing it to boil as it rises to the surface, then separates the steam from the water and uses the steam to turn a turbine generator. There’s one in Japan.

    In binary plants, the hot water flows through heat exchangers, boiling an organic fluid that spins the turbine. For all three types of power plants, the condensed steam and remaining geothermal fluid are injected back into the hot rock to pick up more heat. This is why geothermal energy is viewed as sustainable. It is also very “clean”. Only produces steam.

**-Geothermal Heat**

Even if the geothermal water is not as hot as steam, the warm water can be used to heat buildings, home and even greenhouses. This is routinely done in Russia and Iceland. Using geothermal energy to heat is about 2-3 times as common as using it to create electricity.

**-Limitations**

    Each geothermal field can only be used for a period of time, a few decades, before heat extraction is seriously reduced. Simply put, you can take hot water out of the ground faster than it can be renewed (even if you pump the water back into the ground)

For example, steam pressure at The Geysers has declined rapidly over recent years. It peaked at over 2 billion watts by 1991, but now in 2011 produces about 0.7 billion watts

**-Hydropower**

    A cross-section of a typical hydroelectric dam. Water flows down the penstock, turns the turbine blades which power the generators.

    Water use for generating hydroelectric power is totally dependent on the available water. The Glen Canyon Dam in Utah is the classic example of building too big of dam for not enough water.

    Hydropower is a very clean, pollution-free, renewable energy source

The water is not consumed, but rather simply passes thru the generating equipment, and since several dams may occur along the same river, the water can be reused and reused.

**-Three Gorges Dam**

    The dam is 185 meters (600 feet) high and 2.3 kilometers (1.4 miles) wide. It has 26 hydroelectric power generators with a collective generating capacity of about 18,000 megawatts (the average nuclear power plant generates about 1000 megawatts).

    As with any engineering project of great magnitude, there are serious problems. The reservoir will eventually stretch over 600 kilometers (375 miles) in length. It will submerge 125,000 acres of prime farmland.

    Officials report that the cost is within its US$25 billion budget and insisted early on that the project would pay for itself through electricity generation.

**-Tidal Power**

    All large bodies of water, including the oceans and large lakes, have tides. Tidal power captures the energy contained in moving water mass due to tides.

    Two types of tidal energy can be extracted: Kinetic energy of currents between ebbing and surging tides. Potential energy from the difference in height (or head) between high and low tides. Another option is to use under water turbines, which is like an underwater wind farm.

**-OTEC**

    Ocean energy thermal conversion (OTEC) is a new, clean technology that is still in the developmental stage. It exploits the temperature difference between warm surface water and the cold water at depth to run a “heat engine”

A heat engine is a device placed between a high temperature reservoir and a low temperature reservoir that produces energy

Either the warm water is used directly to run a turbine, or the heat is used to vaporize a working fluid (ammonia) which runs the turbine

    The cold water is used to chill down the water or vapor. Drinkable, distilled fresh water is a by-product.

**-Wind Energy**

    The wind is free, commonly available and can provide clean, pollution-free energy. Today’s wind-turbines are very high tech.

    In most places, the cost of commercial wind power on a large scale is not now economically competitive with conventionally generated electricity. One important factor is that with a doubling of wind speed, power output increases by a factor of 8.

    The U.S. remains the world leader in wind energy, but Europe has embarked on an very ambitious wind-power development program.

    It is predicted that by 2030, wind energy will supply at least twice the electricity it does now.

**-Limitations**

    It would take about 1000 one-million watt windmills to equal the energy output of one sizable fossil fuel power plant. The windmills can be noisy and they are hard on migrating birds.

**-Biomass Energy**

    Biomass energy is derived from organic matter. Stoves that burn wood are the classic example.

**-Biomass Fuels (Biofuels)**

    Biofuels differ from other renewable energy sources, such as wind, hydroelectric, geothermal and solar, as they are primarily used in the transportation sector and are derived from recently living matter, both plant and animal.

**-Ethanol Fuel**

    Ethanol fuel is a biofuel alternative to gasoline, which is gaining popularity world-wide. Car engines can be designed to run on 10%, 50% even 100% pure ethanol.

    It is cleaner burning than gasoline. Worldwide, the use of ethanol is rapidly increasing.

    Automotive ethanol capabilities vary widely country to country, but most spark-ignited gasoline style engines will operate well with mixtures of up to 10% ethanol. Brazil is the world leader in ethanol fuels.

    Ethanol fuel is produced from sugar cane in Brazil, which is a more efficient source of fermentable carbohydrates than corn as well as much easier to grow and process in the tropical climate.

**-“E” Numbers**

    Ethanol fuel mixtures have "E" numbers which describe the percentage of ethanol in the mixture by volume, for example, E85 is 85% ethanol and 15% gasoline.

    Low ethanol blends, from E5 to E25, are also known as gasohol, though internationally the most common use of the term gasohol refers to the E10 blend.

**-Gasohol**

    E10 gasohol is becoming more commonly found at gas stations in the U.S. (Tennessee is way behind). As the “10” indicates it is made from a mixture of gasoline (90%) and ethanol (10%).

    Gasohol has higher octane, or antiknock, properties than gasoline and burns more slowly, more cooler, and more completely, resulting in reduced emissions of some pollutants.

**-UT & Switchgrass**

    The UT Biofuels Initiative has started testing the use of switchgrass, which is believed to offer a greater ethanol yield than corn in a temperate climate, such as in Tennessee.

    The project represents the culmination of years of corporate research and development and a highly touted $40.7 million investment from the state of Tennessee to build a plant for demonstrating technology developed by DuPont Danisco Cellulosic Ethanol.

**-Alternative Energy Sources**

    Most of the world still relies very heavily on fossil fuels, but slowly but surely, attention is being diverted to alternative energy. Energy use in the future will not be dominated by a single source.

    The most important aspects of most alternative energy sources is that they promise clean, pollution-free energy.