* When there’s a huge solar energy spill, it’s just called a ‘nice day’ ” Vote Solar billboard, 2012.

"عندما يكون هناك تسرب ضخم للطاقة الشمسية ، فإنه يطلق عليه" يوم جميل "" التصويت على لوحة للطاقة الشمسية 2012

* I have no doubt that we will be successful in harnessing the sun’s energy. If sunbeams were weapons of war, we would have had solar energy centuries ago.” George Porter, Nobel Prize winner in Chemistry, 1967.

ليس لدي شك في أننا سننجح في تسخير طاقة الشمس. إذا كانت أشعة الشمس أسلحة حرب ، لكنا امتلكنا الطاقة الشمسية منذ قرون ". جورج بورتر الحائز على جائزة نوبل في الكيمياء ، 1967,

* I would put my money on the sun and solar energy. What a source of power! I hope we don’t have to wait until oil and coal run out before we tackle that ” Thomas Edison, 1931

 "كنت أضع أموالي على الشمس والطاقة الشمسية. ما مصدر القوة! آمل ألا نضطر إلى الانتظار حتى نفاد النفط والفحم قبل معالجة ذلك ". توماس اديسون ، 1931

* “It’s really kind of cool to have solar panels on your roof.”

Bill Gates

إنه لأمر رائع حقًا أن يكون لديك ألواح شمسية على سطح منزلك." بيل جيتس

**Why Renewable Energy?**

Renewable energy includes any energy source that replenished at least as fast as it is used. Some examples:

1. Gathering energy from the ocean due to waves,
2. Tides, or thermal gradients;
3. Geothermal energy, which uses the heat of the Earth to generate electricity.
4. Hydroelectric power, which uses moving water to turn a turbine generating electricity.
5. wind power which, uses wind to turn a turbine generating electricity
6. Sunlight, which, can be collected as heat or converted directly into electricity.

 As concerns about rising fossil fuel prices, energy security, and climate change increase, renewable energy can play an important role in producing local, clean, and unlimited energy to supply the nation is increasing demand for electricity, heat, and transportation fuel

Another aspect of energy security is reliability. Renewable sources, especially wind and solar, are well suited to distributed generation meaning the energy source is close to the load.

**Introduction to renewable energy sources**:

 Renewable energy sources derive their energy from existing flows of energy from ongoing natural processes, such as sunshine, wind, flowing water, biological processes, and geothermal heat flows. A general definition of renewable energy sources is that renewable energy is captured from an energy resource that is replaced rapidly by a natural process such as power generated from the sun or from the wind. Currently, the most promising (economically most feasible) alternative energy sources include, solar power, wind power and hydroelectric power (*Therefore, the focus will be on them in this course*). Other renewable sources include geothermal and ocean energies, as well as biomass and ethanol as renewable fuels.

**Solar**:

 One promising technology, solar power is worth considering for it's sustainable, renewable and emissions reducing qualities. Modern residential solar power systems use photovoltaic (PV) to collect the sun’s energy. Photo "means“ produced by light and voltaic ”is“ electricity produced by a chemical reaction PV cells use solar energy to generate a chemical reaction that produces electricity. Each cell contains a semiconductor; most commonly, silicon in one of several forms (single-crystalline, multi-crystalline, or thin-layer), with impurities (either boron or phosphorus) diffused throughout, and covered with a silk screen. Cells joined by a circuit and frame into a module. Semiconductors allow the electrons freed from impurities by the sun’s rays to move rapidly and into the circuit, generating electricity. Commercial residential PV modules range in power output from 10 watts to 300 watts, in a direct current. A PV module must have an inverter to change the DC electricity into alternating current energy in order to be usable by electrical devices and compatible with the electric grid. PV modules can also be used en masse to create large-scale power plants. Using PV modules to generate electricity can significantly reduce pollution. The most energy used in creating solar panels used to purify and crystallize the semiconductor material. No official numbers are available on the exact amount of energy used to create solar panels because there is no industry standard for making the crystals. A number of researchers have done work in attempt to address concerns about energy payback for PV systems. Assuming 12% conversion efficiency and 1,700 kWh/m2 of sunlight per year, the estimates range between 2 and 4 years for rooftop PV systems to generate the energy it took to make them. Over twenty years, a 100-megawatt solar thermal electric power plant can avoid producing over three million tons of carbon dioxide.



 Estimates regarding pollution prevention suggest that producing 1,000 kWh of electricity through solar power can reduce emissions by 8 pounds ≈ (3.628) kg of sulfur dioxide, 5 pounds ≈ (2.267) kg of nitrogen oxide, and 1,400 pounds≈ (635) kg of carbon dioxide. Lifetime estimates (over a projected 28 years) average in the thousands of pounds of prevented emissions. There are other types of solar energy, investment are solar thermal energy, such as solar distillation, solar geyser, solar kitchen, Sunbathing and solar heating.

**Wind**

Wind energy is one of the most promising alternative energy technologies of the future. Throughout recent years, the amount of energy produced by wind-driven turbines has increased exponentially due to significant breakthroughs in turbine technologies, making wind power economically compatible with conventional sources of energy. Wind energy is a clean and renewable source of power. The use of windmills to generate energy has been utilized as early as 5000 B.C., but the development of wind energy to produce electricity was sparked by the industrialization. The new windmills, also known as wind turbines, appeared in Denmark as early as 1890. The popularity of wind energy however has always depended on the price of fossil fuels. For example, after World War II, when oil prices were low, there was hardly any interest in wind power. However, when the oil prices increased dramatically in the 1970s, so did worldwide interest in the development of commercial use of electrical wind turbines. Today, the wind-generated electricity is very close in cost to the power from conventional utility generation in some locations. Where does wind come from? Wind is a form of solar energy and caused by the uneven heating of the atmosphere by the Sun, the irregularities of the Earth’s surface, and rotation of the Earth. The amount and speed of wind depends on the Earth’s terrain and other factors. The wind turbines use the kinetic energy of the wind and convert that energy into mechanical energy, which in turn can be converted into electricity by means of a generator.



There are essentially two types of wind turbines: The horizontal-axis variety, and the vertical axis design. The horizontal-axis design is used more commonly and looks like an Old Dutch windmill, whereas the vertical-axis designs looks like and eggbeater. These wind turbines generally have either two or three blades, called rotors, which are angled at a pitch to maximize the rotation of the rotors. The horizontal-axis design is slightly more efficient and dependable than the vertical-axis windmill. Most of the windmill models that are currently in production are thus horizontal-axis windmills. Utility scale turbines can produce anywhere from 50 kilowatts to several megawatts of energy. These large windmills generally grouped together in a windy area in what called a wind farm. The proximity of the windmills in a wind farm makes it easier to feed the produced electricity into the power grid. Wind energy offers many advantages compared to fossil based power and even some other types of alternative energy, which explains why it is the fastest growing energy source in the world.

The two main reasons are cleanliness and abundance. The fact that wind is a renewable resource gives it a major advantage over oil and the nonrenewable resources. Considering that environmental pollution is being linked to several global problems that might eventually threaten the existence or at the very least worsen human living conditions, the fact that windmills do not produce any emissions whatsoever is another reason to increase the use of wind turbines. Even though wind energy has many environmental and supply advantages, several disadvantages limit the usability of wind power:

 1-The main disadvantage to wind power is that it is unreliable.

 2-Wind does not blow at a constant rate.

 3- It does not always blow when energy needed. Furthermore,

 4-The windiest locations are often in remote locations, far away from big cities where the electricity needed.

Just like with any other energy plant, people oppose it because of aesthetic reasons. The rotor noise produced by the rotor blades is another reason for opposition. Wind seems to be a very good source of alternative energy. Its biggest setback is its unreliability, but in combination with other, more reliable sources, wind energy should use extensively to supplement the demand for energy.



**Hydroelectric Power**

 Hydropower is the most reliable, efficient, and economical, Out of all the renewable power sources, Furthermore, the concept behind hydroelectric power is simple and has been in use for a significant span of time. The earliest reference to the use of the energy of falling water, found in the work of the Greek poet Antipater in the 4th century BC. Indeed, the word “hydro” comes from the Greek language meaning “water.” Several centuries later, the Romans were the first to utilize the waterwheel. Due to the Romans’ powerful influence on Europe through conquest, the waterwheel soon commonly found throughout that continent, and by 1800, tens of thousands of waterwheels had been built. These early waterwheels of course not used for power generation, but mostly for grinding crops. Water energy was first converted into electricity on Sept. 30, 1882 near Appleton, Wisconsin. By 1980 hydroelectric power accounted for about 25% of global electricity and 5% of total world energy use, which amounted to approximately 2,044 billion kilowatt hours (kW h). Harvesting energy from water is possible due to the gravitational potential energy stored in water. As water flows from a high potential energy (high ground) to lower potential energy (lower ground), the potential energy difference thereby created can be partially converted into kinetic, and in this case electric, energy through the use of a generator. There are essentially two major designs in use that utilize water to produce electricity: the hydroelectric dam, and the pumped -storage plant.



The waterwheel discussed at the beginning of this paper is currently no longer in use and has been replaced by the far more economical and efficient dam. Both the waterwheel and the dam work on the same general principle, but the dam has the advantage of being more reliable due to the reservoir behind it. The principle is simple: the force of the water being released from the reservoir through the penstock of the dam spins the blades of a turbine. The turbine connected to the generator that produces electricity. After passing through the turbine, the water reenters the river on the downstream side of the dam. A pumped-storage plant is very similar to the hydroelectric dam, the main difference being that the pumped-storage plant uses two reservoirs, one being considerably higher than the other is. The advantage of this design is that during periods of low demand for electricity, such as nights and weekends, energy stored by reversing the turbines and pumping water from the lower to the upper reservoir. The stored water can later be released to turn the turbines and generate electricity as it flows back into the lower reservoir. Now that the two types of facilities have been discussed, there are also two way of obtaining the water: dam and run-of-the-river. A dam raises the water level of a stream or river to an elevation needed to create the necessary water pressure. In a run-of-the river scenario, the water diverted from its natural path, enters the turbine, and later returned to the river. Hydroelectric power offers several significant advantages compared to fossil based power, and even other types of alternative energy. Probably the most important asset of hydroelectric power is its reliability. Furthermore, it creates no pollution, and once the dam built, even though that process is very expensive, the produced energy is virtually free. A dam has the ability to continuously produce electricity and can adjust to peaks in demand by storing water above the dam and by being able to increase production to full capacity very quickly. Other than the high construction and planning costs, the major drawbacks of large dams are mostly environmental. The dam does not produce harmful emissions as in the case of fossil fuel burning. It does however alter the landscape dramatically, producing several severe, even unbearable changes to the habitat of fish and other plants and animals. Building a large dam will of course flood a large area of land upstream of the dam, causing problems for the animals that used to live there. It furthermore affects the water quantity and quality downstream of the dam, which in turn affects plants and animals. Blocking the river also disallows certain migration pattern of fish. Finding sites that are suitable for dams is also a challenge. Hydroelectric power seems to be a very good source of alternative energy: one that should be maintained at the maximum level possible. It has the main advantage over all the other forms of alternative energy production in that it is reliable, whereas the other forms of alternative energy are not.

 **Geothermal**

Geothermal energy is one of the only renewable energy sources not dependent on the Sun. Instead, it relies on heat produced under the surface of the Earth. Geothermal energy already has several applications and could potentially provide a significant source of renewable power. However, it is limited by a multitude of factors revolving around the issues of sustainability and economics. There are two main applications of geothermal energy, which include producing electricity at specialized power plants, and direct heating, which puts to direct use the temperature of water piped under the earth’s surface. Geothermal power plants take on several types of forms, depending on the type of geothermal area from which they extract energy. In any case, the plants depend on steam to power turbines and generate electricity, though the method of producing steam varies depending on the type of geothermal reservoir. Direct heating, on the other hand, provides immediate usable energy. This type of energy can heat individual buildings or entire areas, as in the city of Klamath Falls, Oregon. It can also cool buildings by pumping water underground where the temperature remains relatively stable near 60 degrees Fahrenheit, and then into buildings, where the water absorbs heat, thus helping to air-condition the building.

 The process involves drilling deep into the surface of the Earth. where temperatures are hot, and then injecting water into cracks of rock, which is heated and then pumped back to the surface. If this “hot dry rock” (HDR) technology proves effective, then more geothermal plants could operate in more locations, since much of the Earth’s surface is underlain by hot, dry rock. Some problems that geothermal energy faces are depletion of both water and heat in geothermal areas. The first problem has been partially addressed, by re-injecting water into reservoirs, thus sustaining the plant’s ability to operate. However, it has been showing that water re-injection can cause small earthquakes, which raises the question of whether the plants should be liable for the damages caused. In Alameda, California, water reinjection at a geothermal power plant triggered earthquakes of magnitudes up to 3.9 and 3.5 on the Richter scale, which were felt 90 miles away in the community of Middletown.

Heat depletion of geothermal areas is more problematic than water depletion in the long run, since it cannot be avoided. It is caused by a natural cooling off , of the earth’s crust, and in these cases, plants would become less and less efficient over several decades until they were rendered useless.

 Geothermal plants can be expensive, depending on factors such as how deep the wells must be drilled and the temperature of the water or steam.

 Another problem that adds cost to geothermal plants is the problem of connecting to energy grids. This is a critical issue because geothermal plants are built where geothermal resources permit- such as geysers and areas with less-heated water. Over time, however, the plants pay for themselves and all the necessary costs because of low operating costs; namely, the fact that the plants energy is free and always available.

Expanding use of geothermal energy depends largely upon the success of the hot dry rock technology and the simultaneous prevention of earthquakes caused by water injection at those plants and water re-injection at other plants. If the HDR technology proves to be viable and safe, geothermal plants can be built in closer proximity to electricity grids, without worrying about geothermal resources like geysers. This would make the plants more cost effective and enable geothermal energy to compete with other energy types.



**Ocean Energy**

Nearly seventy percent of the Earth’s surface is covered by oceans, which have the potential to supply humans with an enormous amount of renewable energy. Humans have exploited the vast energy potential of Earth’s oceans by taking advantage of wave movement, tides, ocean currents, and ocean thermal energy. Europe is the world’s leader in exploiting ocean energy, due in large part to its location and natural geography. For example, winds blown across the Atlantic from west to east naturally increase the size of waves on Europe’s western coast of the west coast of Britain. Larger waves have greater energy, and therefore more power producing ability. ocean energy technology in France, is the world’s largest (240 MW) tidal power plant.52 Tidal power plants such as the one in La Rance, France, operate by damming an estuary and generating electricity from water flowing through turbines. There are a number of variations in terms of exactly how electricity is produced, but one popular method is called ebb generation. At high tide, water flows in through openings in the barrage, or dam, spinning turbines to generate electricity. The water is retained behind the barrage until low tide, when it flows out again, once again spinning the turbines and generating electricity. The predictability of tides makes tidal power a reliable energy source, though it can only produce electricity at certain times of day: during high and low tides. Unfortunately, there are only a handful of places in the world where tidal power generation is efficient.