

# Renewable Energy

What is renewable energy?

Renewable energy is energy that comes from a natural resource that is naturally replenished on a human timescale such as geothermal activity wind and water movement and of course -sunlight.

**Bio-power** is also considered a renewable energy resource, but it does not replenish naturally on a human timescale like the others. Bio-power is the use of biomass to create electricity. It includes wood, plants, residues from agriculture or forestry the organic component of municipal and industrial wastes and the fumes from landfills. There are five major types of bio-power systems: direct-fired, gasification, anaerobic digestion, pyrolysis, and small modular.

## Direct-Fired

Most bio-power plants use direct-fired systems. They burn bioenergy feedstocks directly to produce steam. The steam is then captured by a turbine, and then a generator converts it into electricity.

## Gasification

Gasification systems use high temperatures and an oxygen-starved environment to convert biomass into a gas. The gas then fuels a turbine that turns an electric generator.

## Anaerobic Digestion

The decay of biomass can be used to produce methane gas that is used for an energy source. In landfills, wells are drilled to release the methane from the decaying organic matter. Then pipes from each well carry the gas to a central point where it is filtered, cleaned, and burned.

Methane also can be produced from biomass through a process called anaerobic digestion. Anaerobic digestion involves using bacteria to decompose organic matter in the absence of oxygen.

## Pyrolysis

In addition to gas, liquid fuels can be produced from biomass through a process called pyrolysis. Pyrolysis occurs when biomass is heated in the absence of oxygen. The biomass then turns into a liquid called pyrolysis oil, which can be burned like petroleum to generate electricity.

## Small Modular

Small, modular systems can also produce bio-power. For example, some farmers use the waste from their livestock to provide their farms with electricity. Currently wood is the largest biomass energy resource.

## **Geothermal**

Geothermal energy is produced from the heat of the Earth. Resources for geothermal energy range from the shallow ground to hot water and hot rock found a few miles beneath the Earth's surface, and some, even deeper to the extremely high temperatures of molten rock.

There are three types of geothermal power plants: dry steam, flash steam, and binary cycle.

### Dry Stream

Dry steam power plants draw steam from underground resources and pipe it to a power plant where it is directed into a turbine/generator unit. There are only two known underground resources of steam in the United States: The Geysers in northern California and Yellowstone. Yellowstone is protected from development, so the only dry steam plants in the country are at The Geysers.

### Flash Steam

Flash steam power plants are the most common. They use geothermal reservoirs of water with temperatures greater than 360°F. This very hot water flows up through wells in the ground under its own pressure. As it flows upward, the pressure decreases and some of the hot water boils into steam. This steam is separated from the water and used to power turbines/generators. Any leftover water and condensed steam are injected back into the reservoir. The Coso Geothermal power plants that are located partially in Inyo County use the flash steam method to generate electricity.

### Binary cycle

Binary cycle power plants operate with water at lower temperatures of about 225°-360°F. These plants use the heat from the hot water to boil a working fluid. This is usually an organic compound with a low boiling point. The working fluid is vaporized in a heat exchanger and used to turn a turbine. The water is then injected back into the ground to be reheated.

Geothermal energy can only be produced where the resources are located making it geographically limited and predictable. The Coso Geothermal power plants are the only geothermal plants in Inyo County.

### **Hydroelectric**

Hydroelectric power is generated by flowing water. This is commonly done with dams and canals and more recently ocean waves and tides. There are also pumped storage plants.

### Dams and Canals

The most common type of hydroelectric power plant uses a dam on a river to store water in a reservoir. Water is released from the reservoir and flows through a turbine, spinning it, which in turn activates a generator to produce electricity. Hydroelectric power does not always require a large dam, though. Some hydroelectric power plants use a small canal to channel water from a stream, through a turbine. Inyo County has both of these types of hydroelectric power generation facilities.

### Pumped Storage Plants

Another type of hydroelectric power plant is called a pumped storage plant. These can store power. The power is sent from a power grid into the electric generators. The generators spin the turbines backward, which causes them to pump water from a river or lower reservoir to an upper reservoir, where the power is stored. To use the stored power, the water is released from the upper reservoir back down into the river or lower reservoir spinning the turbines forward, and activating the generators to produce electricity.

Hydroelectric generation, like geothermal, is limited geographically to the source. It is beginning to fall out of favor in many areas due to concerns over fisheries that is causing dams to be removed.

Most of the County's current work on renewable energy has focused on wind and solar. This is because there is already sufficient policy and regulation in place for geothermal and hydroelectric facilities and there is not enough population or biomass resources in the county for bio-energy production to happen at a scale that requires regulation at this time.

### **Wind Energy**

Wind turbines, like the windmills of old, are mounted on a tower to capture wind energy. At about 100-feet or more aboveground, they can take advantage of faster and less turbulent wind resources. The turbines catch the wind's energy with propeller-like blades, usually there are two or three blades mounted on a shaft to form a rotor. These blades act much like an airplane wing. When the wind blows, a pocket of low-pressure air forms on the downwind side of the blade and this low-pressure air pocket then pulls the blade toward it, causing the rotor to turn. This is called lift. The force of the lift is actually much stronger than the wind's force against the front side of the blade, which is called drag. The combination of lift and drag causes the rotor to spin like a propeller, and the turning shaft spins a generator to make electricity. Wind turbines can be used as stand-alone applications, or they can be connected to a utility power grid.

### Wind Farms

For utility-scale sources of wind energy, a large number of wind turbines are usually built close together to form a wind plant. These generate from 5-to several hundred-megawatts and can require a lot of land for production.

### Stand Alone Turbines

Stand-alone wind turbines are typically used for water pumping or communications. However, homeowners, farmers, and ranchers in windy areas can also use wind turbines as a way to cut their electric bills.

Currently there are standalone wind turbines in the county for private use. The county does not have large wind energy facilities.

### **Solar**

There are two basic types of solar electricity generating facilities concentrating solar and photovoltaic.

The three main types of concentrating solar power systems are parabolic-trough, dish/engine, and power tower.

### Parabolic-Trough Systems

Parabolic-trough systems concentrate the sun's energy through long rectangular, curved (U-shaped) mirrors. The mirrors are tilted toward the sun, focusing sunlight on a pipe that runs down the center of the trough. This heats oil that is flowing through the pipe. The hot oil then is used to boil water in a conventional steam generator to produce electricity.

### Dish Engine System

A dish/engine system uses a mirrored dish (similar to a very large satellite dish). The dish-shaped surface collects and concentrates the sun's heat onto a receiver, which absorbs the heat and transfers it to a fluid within the engine. The heat causes the fluid to expand against a piston or turbine to produce mechanical power. The mechanical power is then used to run a generator or alternator to produce electricity.

### Power Tower System

Power tower systems use a large field of mirrors to concentrate sunlight onto the top of a tower where a receiver sits. This heats molten salt flowing through the receiver. Then, the salt's heat is used to generate electricity through a conventional steam generator. Molten salt retains heat efficiently, so it can be stored for days before being converted into electricity. That means electricity can be produced on cloudy days or even several hours after sunset.

Concentrating solar electric generating facilities can produce hundreds of megawatts of electricity, but they also take up large areas of land (thousands of acres) and are becoming a less popular option than they used to be. There are no concentrating solar electric generating facilities in Inyo County. The Bight Source project that was to be located in Charleston View was a power tower system.

### Photovoltaic

In a photovoltaic system, solar cells convert sunlight directly into electricity. Solar cells are made of semiconducting materials similar to those used in computer chips. When sunlight is absorbed by these materials, the solar energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity. This process of converting light (photons) to electricity (voltage) is called the photovoltaic (PV) effect.

Photovoltaic technologies have been advancing quite rapidly and are becoming the more popular option in solar electricity generation. Inyo County currently has small photovoltaic systems scattered throughout. They can be found on schools, county and city facilities, tribal lands, and on private homes.