

Topic 4 - The Energy Connection

The scientific definition of energy is *'the ability to do work'*.

The four most common forms of energy are:

- *chemical* - potential or stored energy stored in chemicals, released when the chemicals react.
- *electrical* - energy of charged particles, transferred when they travel from place to place.
- *mechanical* - energy possessed by an object because of its motion or its potential to move.
- *thermal* - kinetic energy of a substance

Electricity and Heat

A *thermocouple* is a device that can convert *thermal energy* into *electrical energy*. It consists of two different metals (bimetal) joined together that conduct heat at slightly different rates. When heated, the difference in conduction results in electricity flowing from one metal to the other.

The basic principle of the thermocouple was discovered by Thomas Johann Seebeck in 1821, and was named the *Seebeck Effect*.

Thermocouples are useful for measuring temperatures in areas that are difficult to access or too hot for a regular liquid-filled thermometer. Ovens and heaters do the opposite. They convert electrical energy into thermal energy.

A *thermo-electric generator* is a device based on a thermocouple that converts heat directly into electricity without moving parts. Several thermocouples connected in a series is called a *thermopile*. Thermopiles are extremely reliable, low-maintenance devices and are often used in remote locations for emergency power generation.

Electricity to Motion

The *piezoelectric effect* produces sound by converting electricity into motion (vibrations). When a piezoelectric crystal, such as quartz, or Rochelle salt is connected to a potential difference, the crystal expands or contracts slightly. Material touching the crystal experiences pressure, creating sound waves or vibrations.

Motion to Electricity

A barbeque spark lighter uses the *piezoelectric effect in reverse*. When a crystal or Rochelle salt is compressed or pulled, a potential difference is built up on the opposite sides of the crystal. Conductors then take this through a circuit to produce electric energy (a spark).

Electricity to Light

An incandescent resistance filament (load) glows white-hot when electricity is passed through it. In fluorescent tubes a gas glows brightly and when crystals are struck together they can produce light. *LED's* (light-emitting diodes) are solid –state components that use a fraction of the power. When connected to a semiconductor chip in the right direction, they will produce light and last for many years.

Light to Electricity

Solar panels, containing photovoltaic cells can convert light into electrical energy. The *photovoltaic (PV) cells*, or solar cells, are made of semiconductor materials, such as silicon. When light is present, the material, breaking electrons loose – allowing them to flow freely, absorbs some. This current is drawn off by metal contacts on the top and bottom of the cell and then used in devices such as calculators, heater, or emergency telephones. Individual solar cells are combined in modules, to form arrays to produce larger amounts of electric current. Certain animals, namely, the electric eel, can produce electric shock, to kill or stun prey. They have a special organ that contains specialized muscle cells called *electroplaques*. Each cell produces a small amount of electricity. When all the cells work together, a large amount of electricity is produce and used to help the eel survive. This type of electricity is like static electricity, which builds up and then discharges.