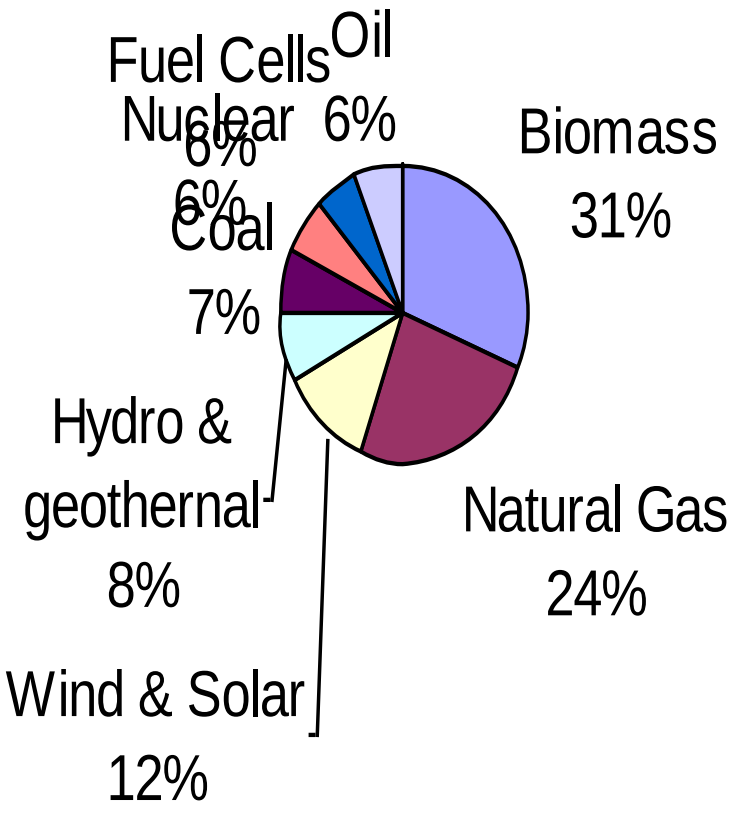
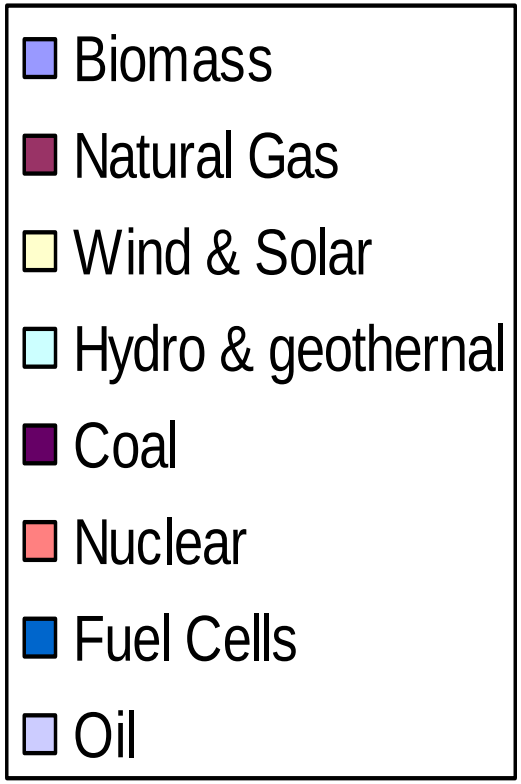
ALTERNATIVE ENERGY

Alternative Energy Future for U.S.





BIOFUELS

PLANT MATERIALS → BAGASS

WOOD DUNG → METHANE

BIOMASS

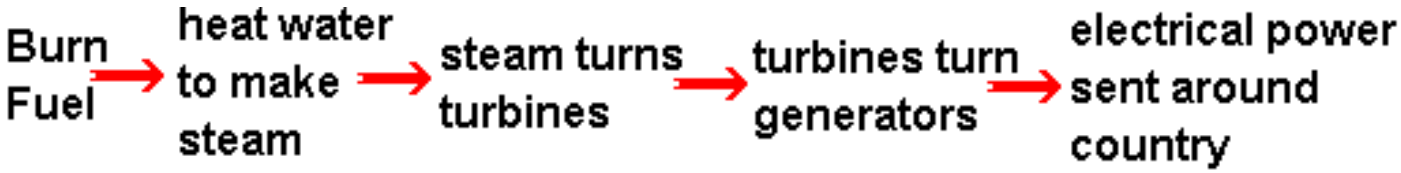
Wood was once our main fuel. We burned it to heat our homes and cook our food.
Wood still provides a small percentage of the energy we use, but its importance as an energy source is dwindling.

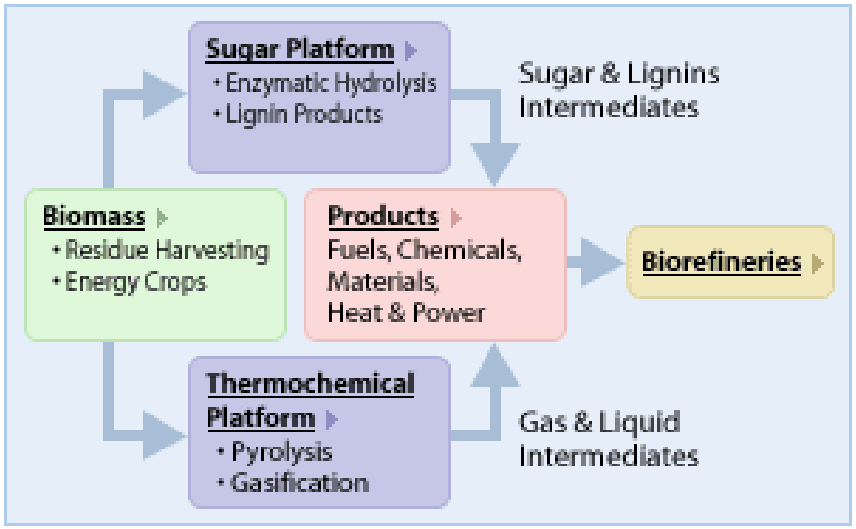
Sugar cane is grown in some areas, and can be fermented to make alcohol, which can be burned to generate power in the same way as coal. Alternatively, the cane can be crushed and the pulp (called "bagasse") can be burned, to make steam to drive turbines.

Other solid wastes, can be burned to provide heat, or used to make steam for a power station.
"Bioconversion" uses plant and animal wastes to produce fuels such as methanol, natural gas, and oil.
We can use rubbish, animal manure, woodchips, seaweed, corn stalks and other wastes.

BIOMASS: How it works

The fuel is burned, which heats water into steam, which turns turbines, which in turn drive generators, just like in a fossil-fuel power station. The U.S. = 3% of our energy needs.





BURNING BIOMASS = 15% global fuel (mostly wood in LDC's)

PROS:

1. Renewable as long as consumption does not exceed rate of replenishment.

2. Rate of use balanced with rate of renewal does not upset CO2 balance.

3. Less SO2, NOx produced than coal.

4. Can be sustainable if issues of deforestation, soil erosion, & inefficiency of burning are controlled.

5. Could supply ½ of the world's electrical needs.

6. Plantations of trees could be planted in less desirable locations & help stabilize soil erosion & restore degraded land.

7. Reduces impacts on landfills.

CONS:

1. Current rate is unsustainable.

2. Requires fertilization which is mostly produced from fossil fuels.

3. Deforestation.

4. Soil erosion.

5. Loss of wildlife habitat.

6. Inefficient methods of burning cause air pollution.

7. Expensive to transport.

8. 70% of energy is lost during conversion to electricity.

Sugar cane

Sugar cane is harvested and taken to a mill, where it is crushed to extract the juice. The juice is used to make sugar, whilst the left-over pulp, called "bagasse" can be burned in a power station.

The station usually provides power for the sugar mill, as well as selling electricity to the surrounding area.

Advantages

•It makes sense to use waste materials where we can.
The fuel tends to be cheap.
Less demand on the Earth's resources.

Disadvantages

•Collecting the waste in sufficient quantities can be difficult.

We burn the fuel, so it makes greenhouse gases.

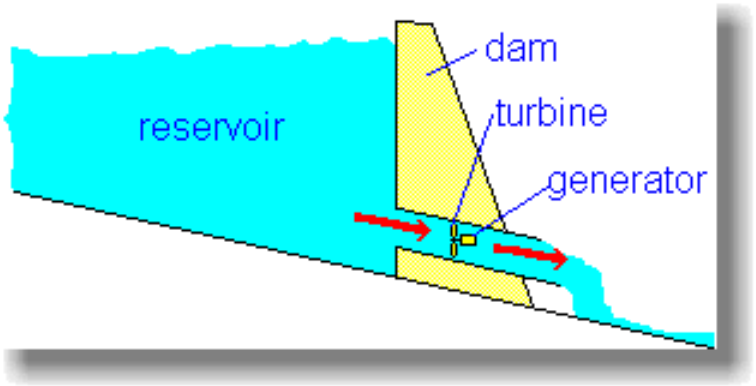
Some waste materials are not available all year round.

•The waste is not used to replenish the soil nutrients.

Using the power of Water

HYDROELECTRIC POWER

Hydroelectric Dams



Low Head Hydropower – Uses smaller dams that cause much less damage.

Run of the river flow – Uses small submerged turbines that don't disrupt navigation & cause little environmental damage.

Micro-hydro-generators – small enough to provide economical power for single homes located next to a free flowing river.

OTEC – OCEAN THERMAL ELECTRIC CONVERSION

CLOSED SYSTEM – Warm surface water (contained in a pipe) evaporates ammonia or freon. The pressure of the gas is used to turn turbines. Cold water is piped up from depths (1000m) & used to condense the warm water.

OPEN CYCLE SYSTEM – Uses seawater itself as the working fluid. Warm seawater is sprayed into a chamber, where low air pressure causes some water to evaporate. The resulting water vapor drives the generator & then passes through 2 condensers cooled by deep cold water. This produces distilled (desalinized) water.

OR Cold water is sprayed into the steam flow & creates a vacuum that drives the system.

OTEC PROS: Produces electricity AND fresh water.

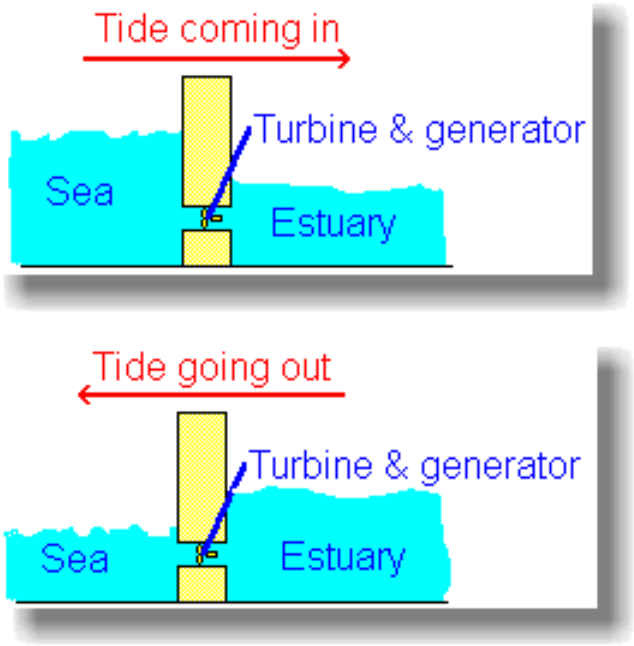
CONS: Expensive to install, energy cost of pumping up cold water, saltwater corrosion of pipes & equipment, vulnerability to storms, ecological destabilization from upwelling of nutrients & alteration of water temperatures.

TIDAL POWER –

Tidal power works rather like a hydro-electric scheme, except that the dam is **much** bigger.

A huge dam (called a "barrage") is built across a river estuary. When the tide goes in and out, the water flows through tunnels in the dam.

The ebb and flow of the tides can be used to turn a turbine, or it can be used to push air through a pipe, which then turns a turbine. Large lock gates, like the ones used on canals, allow ships to pass.



Advantages

•Once you've built it, tidal power is almost free (maintenance).

•It produces no greenhouse gases or other waste.

It needs no fuel.

It produces electricity reliably.

Not expensive to maintain.

Tides are totally predictable.

Offshore turbines and vertical-axis turbines are not ruinously expensive to build and do not have a large environmental impact.

•Renewable.

Disadvantages

•A barrage across an estuary is very expensive to build, and affects a very wide area - the environment is changed for many miles upstream and downstream. Many birds rely on the tide uncovering the mud flats so that they can feed. there are few suitable sites for tidal barrages.

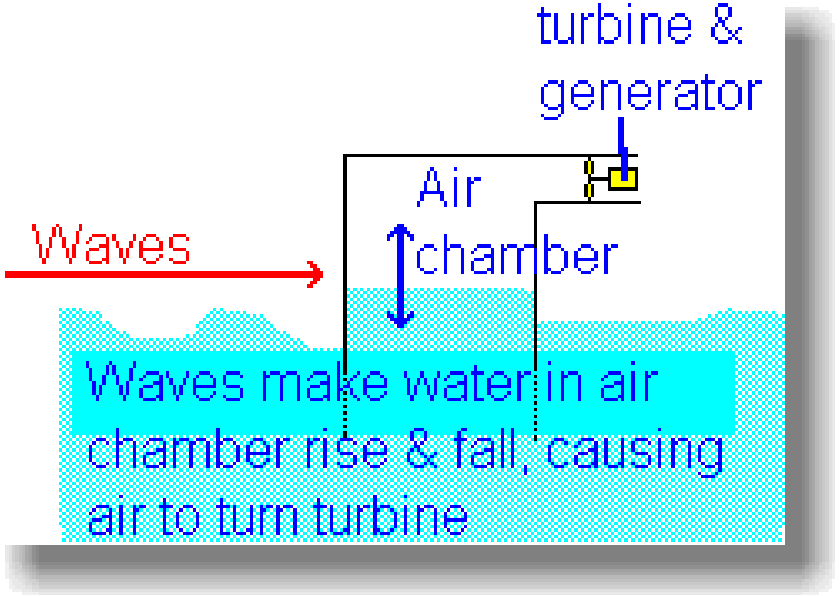
Only provides power for around 10 hours each day, when the tide is actually moving in or out.

WAVES FOR POWER

There are several methods of getting energy from waves, but one of the most effective works like a swimming pool wave machine in reverse.
At a wave power station, the waves arriving cause the water in the chamber to rise and fall, which means that air is forced in and out of the hole in the top of the chamber.

We place a turbine in this hole, which is turned by the air rushing in and out. The turbine turns a generator.
A problem with this design is that the rushing air can be very noisy, unless a silencer is fitted to the turbine. Waves themselves are noisy.

Wave generator



WIND POWER

The Sun heats our atmosphere unevenly, so some patches become warmer than others.

These warm patches of air rise, other air blows in to replace them - and we feel a wind blowing.

We can use the energy in the wind by building a tall tower, with a large propeller on the top.

The wind blows the propeller round, which turns a generator to produce electricity. Many of these towers together make a "wind farm" and produce more electricity. The larger the propellers, the more electricity we can make.

To be worthwhile, you need an average wind speed of around 25 km/h.

Some designs use vertical turbines, which don't need to be turned to face the wind.

The towers are tall, to get the propellers as high as possible, up to where the wind is stronger. This means that the land beneath can still be used for farming.

Advantages

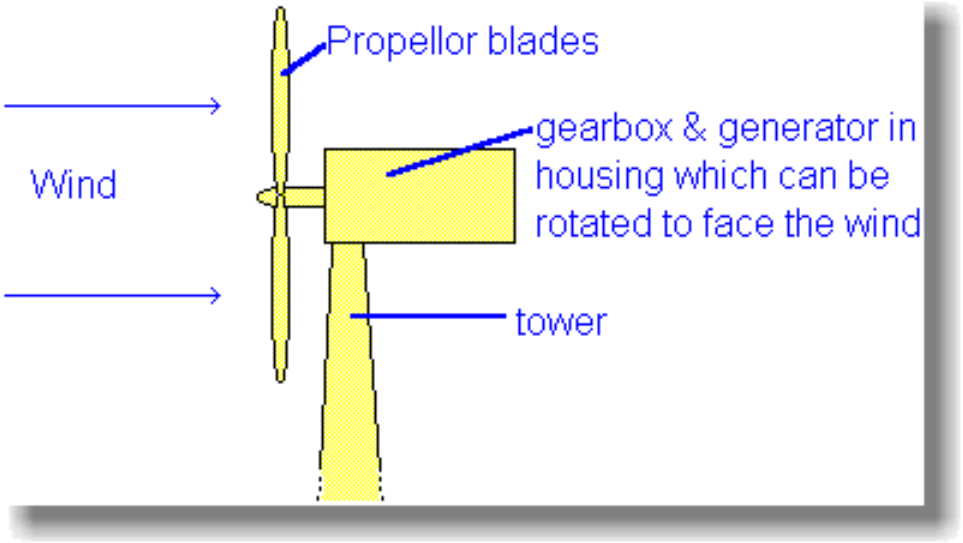
•Wind is free, wind farms need no fuel.

Produces no waste or greenhouse gases.

The land beneath can usually still be used for farming.

Wind farms can be tourist attractions.

A good method of supplying energy to remote areas.



wind power annimation

Disadvantages

•The wind is not always predictable - some days have no wind.

Suitable areas for wind farms are often near the coast, where land is expensive.

Some people feel that covering the landscape with these towers is unsightly.

Can kill birds - migrating flocks tend to like strong winds. Splat!

Can affect television reception if you live nearby.

Noisy. A wind generator makes a constant, low, "swooshing" noise day and night, which can drive you nuts. An entire wind farm makes quite a racket!

GEOTHERMAL POWER

The center of the Earth is around 6000 degrees Celsius - hot enough to melt rock. Even a few kilometers down, the temperature can be over 250 degrees Celsius.

In general, the temperature rises one degree Celsius for every 36 meters you go down.

In volcanic areas, molten rock can be very close to the surface.

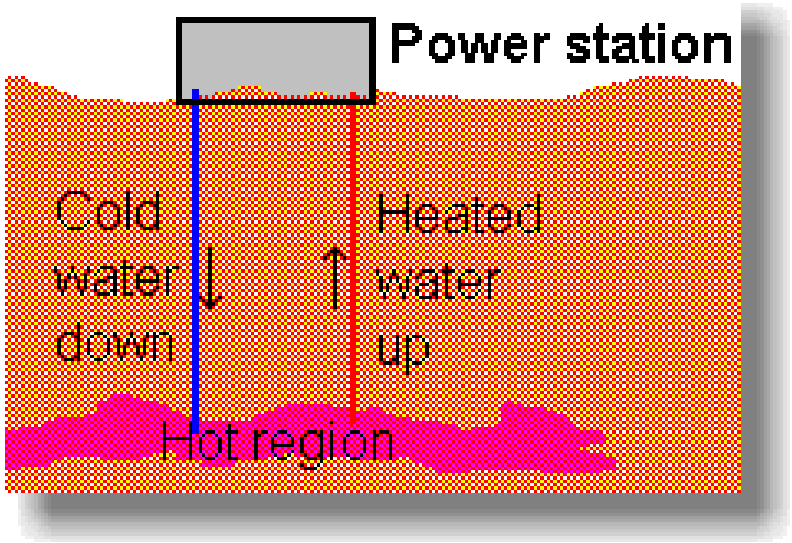
Geothermal energy has been used for thousands of years in some countries for cooking and heating.

The name "geothermal" comes from two Greek words: "geo" means "Earth" and "thermal" means "heat".

How it works

Hot rocks underground heat water to produce steam.
We drill holes down to the hot region, steam comes up, is purified and used to drive turbines, which drive electric generators.

There may be natural "groundwater" in the hot rocks anyway, or we may need to drill more holes and pump water down to them.



Water is pumped down an "injection well", filters through the cracks in the rocks in the hot region, and comes back up the "recovery well" under pressure. It "flashes" into steam when it reaches the surface.

The steam may be used to drive a turbogenerator, or passed through a heat exchanger to heat water to warm houses. A town in Iceland is heated this way. The steam must be purified before it is used to drive a turbine, or the turbine blades will get "furred up" like your kettle and be ruined.

Advantages

•Geothermal energy does not produce any pollution, and does not contribute to the greenhouse effect.

The power stations do not take up much room, so there is not much impact on the environment.

No fuel is needed.

Once you've built a geothermal power station, the energy is almost free.
It may need a little energy to run a pump, but this can be taken from the energy being generated.

Disadvantages

•The big problem is that there are not many places where you can build a geothermal power station.
You need hot rocks of a suitable type, at a depth where we can drill down to them.
The type of rock above is also important, it must be of a type that we can easily drill through.

•Sometimes a geothermal site may "run out of steam", perhaps for decades.

Hazardous gases and minerals may come up from underground, and can be difficult to safely dispose of.

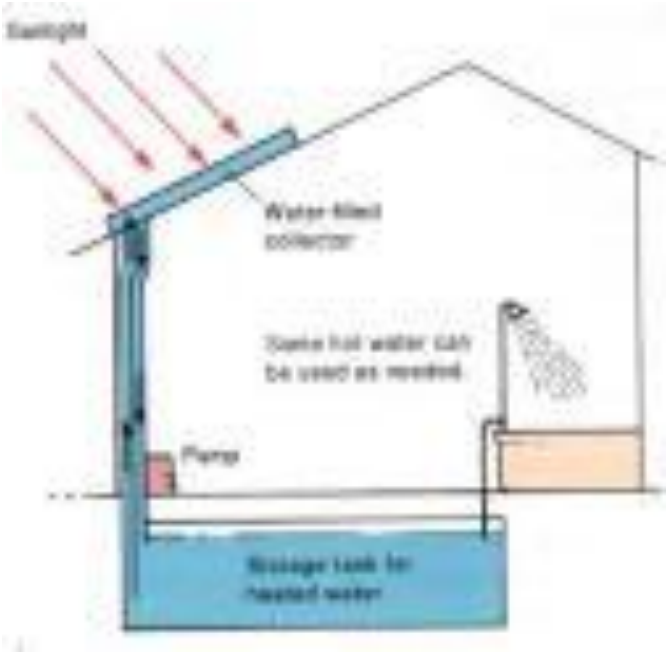
Solar technologies use the sun's energy and light to provide heat, light, hot water, electricity, and even cooling, for homes, businesses, and industry.

Photovoltaic (solar cell) systems convert sunlight directly into electricity. A solar or PV cell consists of semiconducting material that absorbs the sunlight. The solar energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity. PV cells are typically combined into modules that hold about 40 cells. About 10 of these modules are mounted in PV *arrays*. PV arrays can be used to generate electricity for a single building or, in large numbers, for a power plant.

A power plant can also use a *concentrating solar power system*, which uses the sun's heat to generate electricity. The sunlight is collected and focused with mirrors to create a high-intensity heat source. This heat source produces steam or mechanical power to run a generator that creates electricity.

Solar water heating systems for buildings have two main parts: a solar collector and a storage tank. Typically, a *flat-plate collector*—a thin, flat, rectangular box with a transparent cover—is mounted on the roof, facing the sun. The sun heats an *absorber plate* in the collector, which, in turn, heats the fluid running through tubes within the collector. To move the heated fluid between the collector and the storage tank, a system either uses a pump or gravity, as water has a tendency to naturally circulate as it is heated. Systems that use fluids other than water in the collector's tubes usually heat the water by passing it through a coil of tubing in the tank.

Many large commercial buildings can use solar collectors to provide more than just hot water. Solar process heating systems can be used to heat these buildings. A solar ventilation system can be used in cold climates to preheat air as it enters a building. And the heat from a solar collector can even be used to provide energy for cooling a building.



Active solar systems use a pump to circulate heated fluids

PASSIVE SOLAR SYSTEMS:

Buildings usually have large, south-facing windows. Materials that absorb and store the sun's heat can be built into the sunlit floors and walls. The floors and walls will then heat up during the day and slowly release heat at night—a process called *direct gain*. Many of the passive solar heating design features also provide *daylighting*. Daylighting is simply the use of natural sunlight to brighten up a building's interior.

Passive systems also use the angle of the roof to allow low angle sunlight rays to warm the house in winter yet block higher angle (more intense) summer sunlight.

Trees planted along south facing windows allow light in during the winter months but block summer sunlight.

Photovoltaics

Photovoltaic cells, which directly convert sunlight into electricity, are made of semiconducting materials. The simplest photovoltaic cells power watches and calculators and the like, while more complex systems can light houses and provide power to the electrical grid.

Technologies Crystalline silicon (c-Si) is the leading commercial material for photovoltaic cells.

Hydrogen fuel cells:

A fuel cell uses the chemical energy of hydrogen to produce electricity and water, cleanly and efficiently. Fuel cells are unique in terms of the variety of their potential applications; they can provide energy for systems as large as a utility power station and as small as a smoke detector.

How Does a Fuel Cell Work?

A fuel cell is a device that uses hydrogen (or hydrogen-rich fuel) and oxygen to create electricity by an electrochemical process. A single fuel cell consists of an electrolyte and two catalyst-coated electrodes (a porous anode and cathode). While there are different fuel cell types, all work on the same principle:

Hydrogen, or a hydrogen-rich fuel, is fed to the anode where a catalyst separates hydrogen's negatively charged electrons from positively charged ions (protons).

•At the cathode, oxygen combines with electrons and, in some cases, with species such as protons or water, resulting in water or hydroxide ions, fuel cell animation.

PROS: Fuel cells have several benefits over conventional combustion-based technologies currently used in many power plants and passenger vehicles. They produce much smaller quantities of greenhouse gases and none of the air pollutants that create smog and cause health problems. If pure hydrogen is used as a fuel, fuel cells emit only heat and water as a byproduct.

CONS: SAFETY

Hydrogen, like most fuels, has a high energy content and must be handled properly to be safe. It is odorless, flammable (like gasoline), and burns with an invisible flame that can make it difficult to detect or extinguish. However, hydrogen has been used safely for decades by industry in a wide variety of applications and conditions, and it can be used safely by consumers with proper handling and engineering controls. In fact, hydrogen has several properties that make it safer than other fuels used today. For example, it's non-toxic (unlike gasoline), and it dissipates rapidly when released, such as from a leak. As with any other fuel, engineers will have to design products that use hydrogen safely, and users will have to become familiar with hydrogen and its properties so they can use it without incident.