

RENEWABLE ENERGY

Chapter 10

Renewable energy sources

- Nations are looking for ways to move away from fossil fuels while ensuring a reliable source of energy.
- Biomass and hydropower are well-established and widely used.
- “New” renewables are less used and their technologies are still being developed.
 - These include:

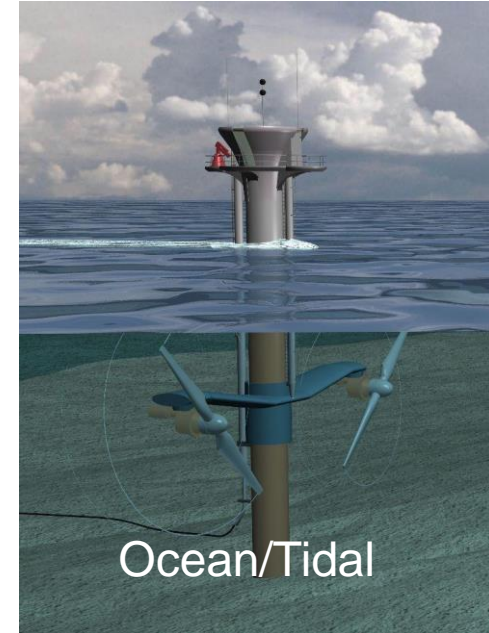
Solar



Wind



Geothermal Heat

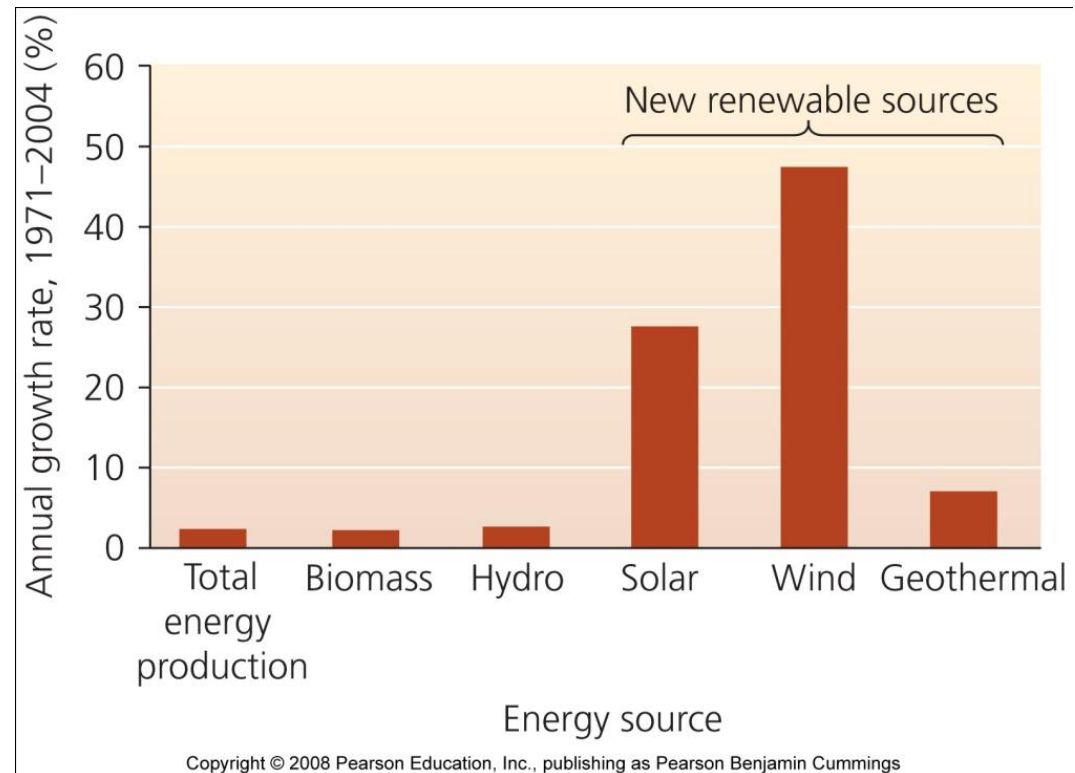


Why Use Renewable Energy Sources?

- In addition to being inexhaustible, renewables can:
 1. Diversify an economy's energy mix
 2. Create **green-collar jobs**: a major new source of jobs dealing with the design, installation and management of renewable energies
 3. And of major importance – Renewable energy sources can **reduce greenhouse gas emissions**

“New” renewables are growing fast

- “New” renewable energy sources are growing at much faster rates than conventional sources.



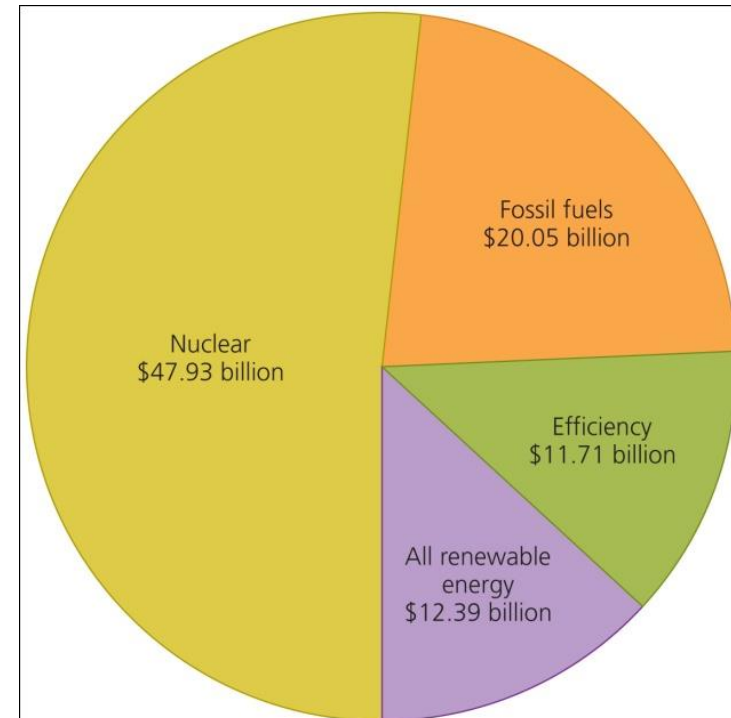
Why Look Toward Renewable Energy?

- We need more and more energy because:
 1. Human population keeps growing!
 2. Therefore, energy demand & consumption keep growing;
 3. Fossil fuel supplies are exhaustible;

Why Don't We Use More Renewable Energy If It's So Great?

- Technological and economic barriers prevent a quick switch to renewables.
- Renewables receive little government help/funding

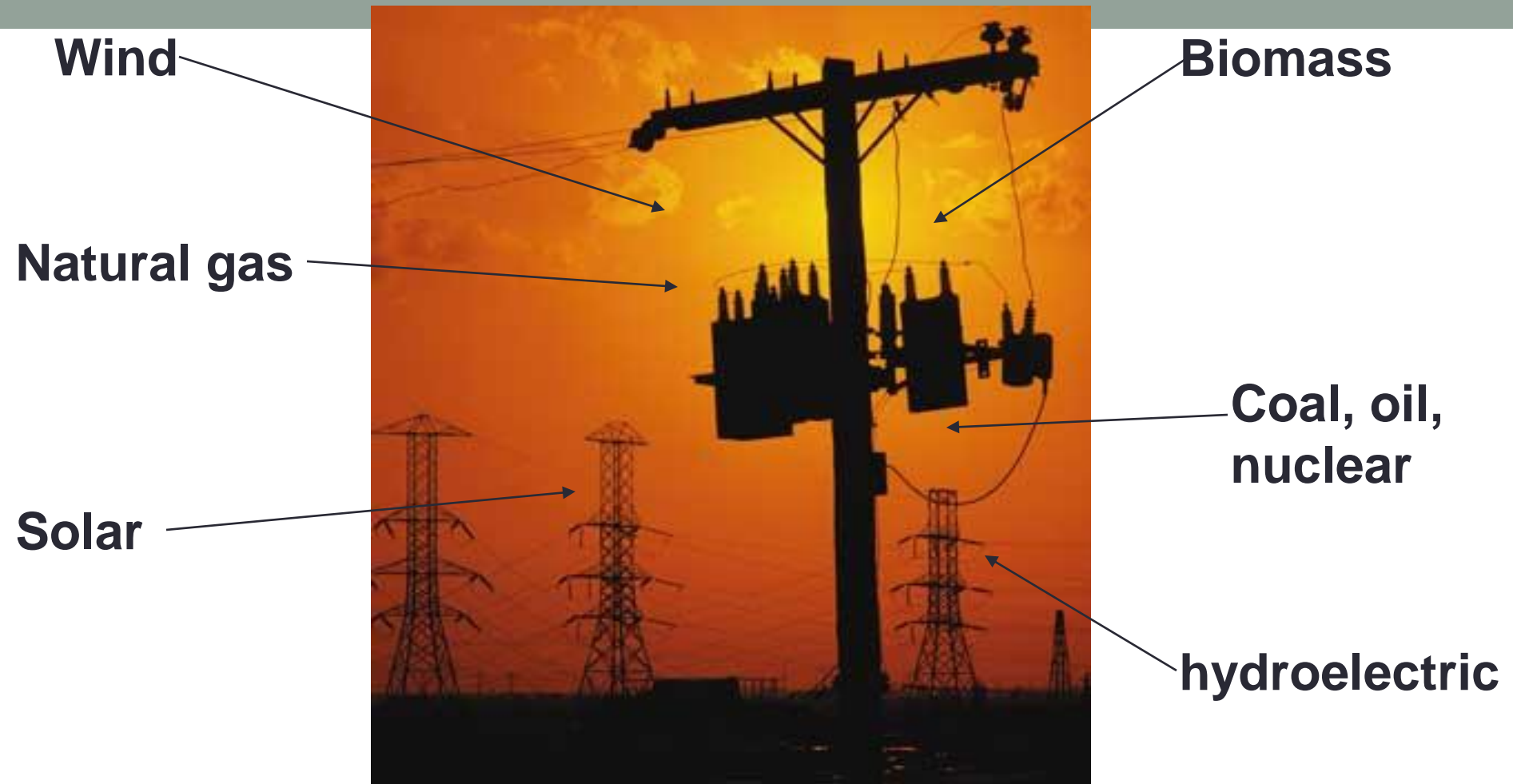
The 2007 energy bill passed only after Congress dropped requirements to shift subsidies from non-renewables to renewables and for utilities to increase using renewables.



Renewable Energy

(AKA “Green” or Alternative Energy)

- We will cover the following types of renewable energy:
 1. Biomass
 2. Solar Power
 - Mirror systems
 - Photovoltaic systems
 3. Wind
 4. Geothermal
 5. Hydroelectric
 6. Fuel Cells (with Hydrogen)
 7. Biofuels



In the Coachella Valley, electricity comes from **both** renewable and non-renewable energy sources. An increase in renewable energy = a decrease in non-renewable energy.

BIOMASS

BIOMASS

- Biomass is wood waste from construction sites, shipping pallets, agricultural fields, & orchards.
- It is burned to heat water and produce steam for steam turbine generators that make electricity.
- This waste would otherwise go to a landfill or be burned in an open field.



Desert View Power energy plant in Mecca, CA

BIOMASS PROS & CONS

Pros:

- Biomass, or wood waste, is renewable.
- Biomass Plants, such as Desert View Power, go to great lengths to ensure that emissions are clean. NO_x, SO_x, CO, and PM are removed.
- Using the wood waste to generate electricity prevents it from going to a landfill or being burned in an open field.

Cons:

- Biomass power plants **must pay for** the wood waste. Those who create the waste matter are paid by Desert View Power to deliver it to the plant. This reduces the cost effectiveness of biomass energy.
- It should be the other way around – those who create the waste should pay the power plant to take it just as the ***Polluter Pays Principle*** stipulates.

Polluter Pays Principle

- The Polluter Pays Principle is when the polluting party pays for the damage done to the environment from the pollution they create.
- Basically, we know that pollution is going to result from the creating of a product or using a product – whether it be electricity from the burning of coal, or producing waste from mining, etc. – and that pollution must be mitigated in some way.
- In the U.S. – we don't use the Polluter Pays Principle – we use lawsuits. . .this is one reason our gas is so cheap compared to Europe!
- Europe uses the Polluter Pays Principle and ties in the costs of mitigating the pollution that comes from using gasoline for transportation into the cost of the gas.
- So, the price of Europe's gas stays pretty constant, but is much more expensive because they are already paying for the pollution that using that gas will cause – they are already accounting for the mitigation needed.

SOLAR ENERGY

2 Types of Solar Energy

Passive

- Absorb solar heat with stationary materials & structures. (e.g. adobe houses)
- Opening the curtains to warm a room with sunlight is using passive solar heat.

Active

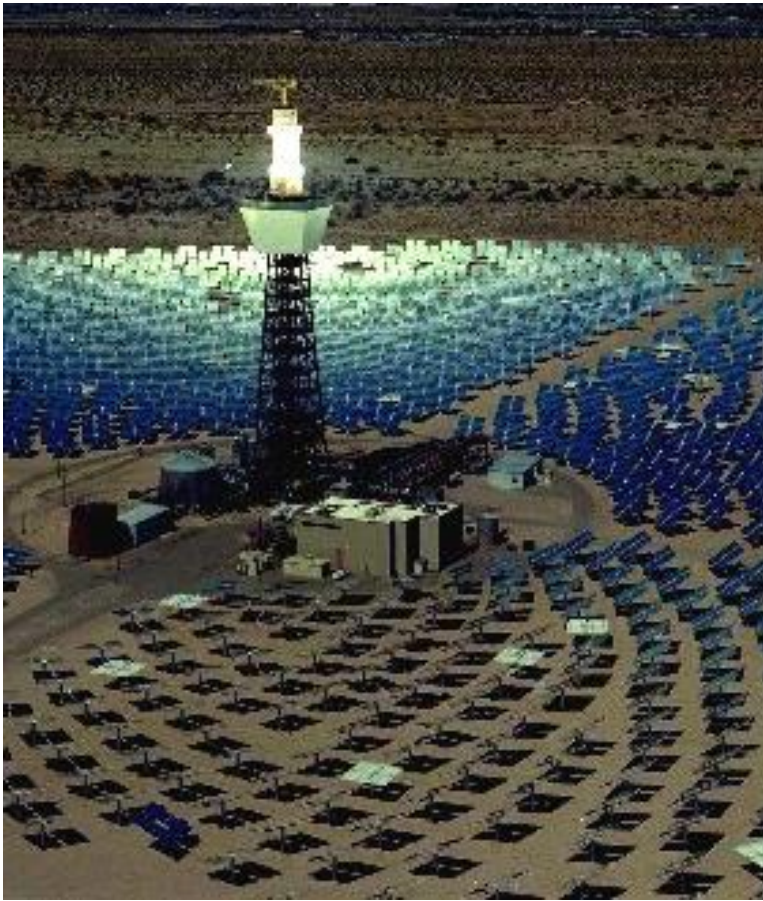
- Actively concentrating and converting solar energy into heat and electricity. (e.g. pump heat absorbing material through a heat collector)
- *Solar Mirrors and Photovoltaic Energy* are active solar heat methods.

Solar Mirror Systems

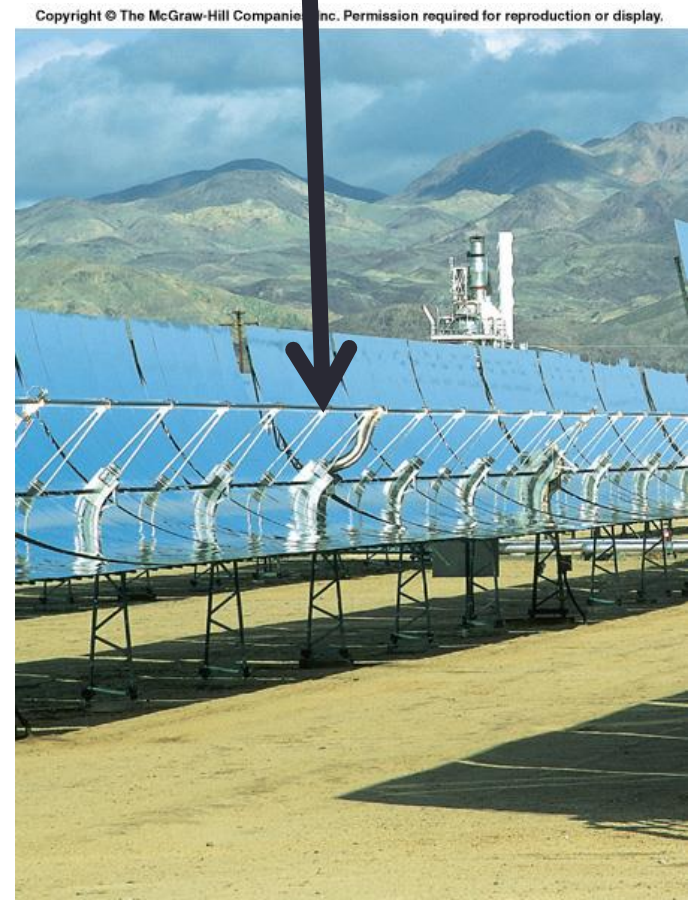
- Mirrors reflect the sun's light onto a specific container.
 - This container is either a tube running along a parabolic mirror, or a reservoir at the top of a tower that contains a heat-absorbing fluid.
 - This fluid is used to heat water in order to produce steam to drive a turbine generator.
- These systems are capable of powering thousands of homes & businesses.

2 TYPES OF SOLAR MIRROR SYSTEMS

Power Tower System: mirrors in concentric circles focusing light on the tower.



Parabolic Mirror System
Central tube containing a fluid that absorbs heat .



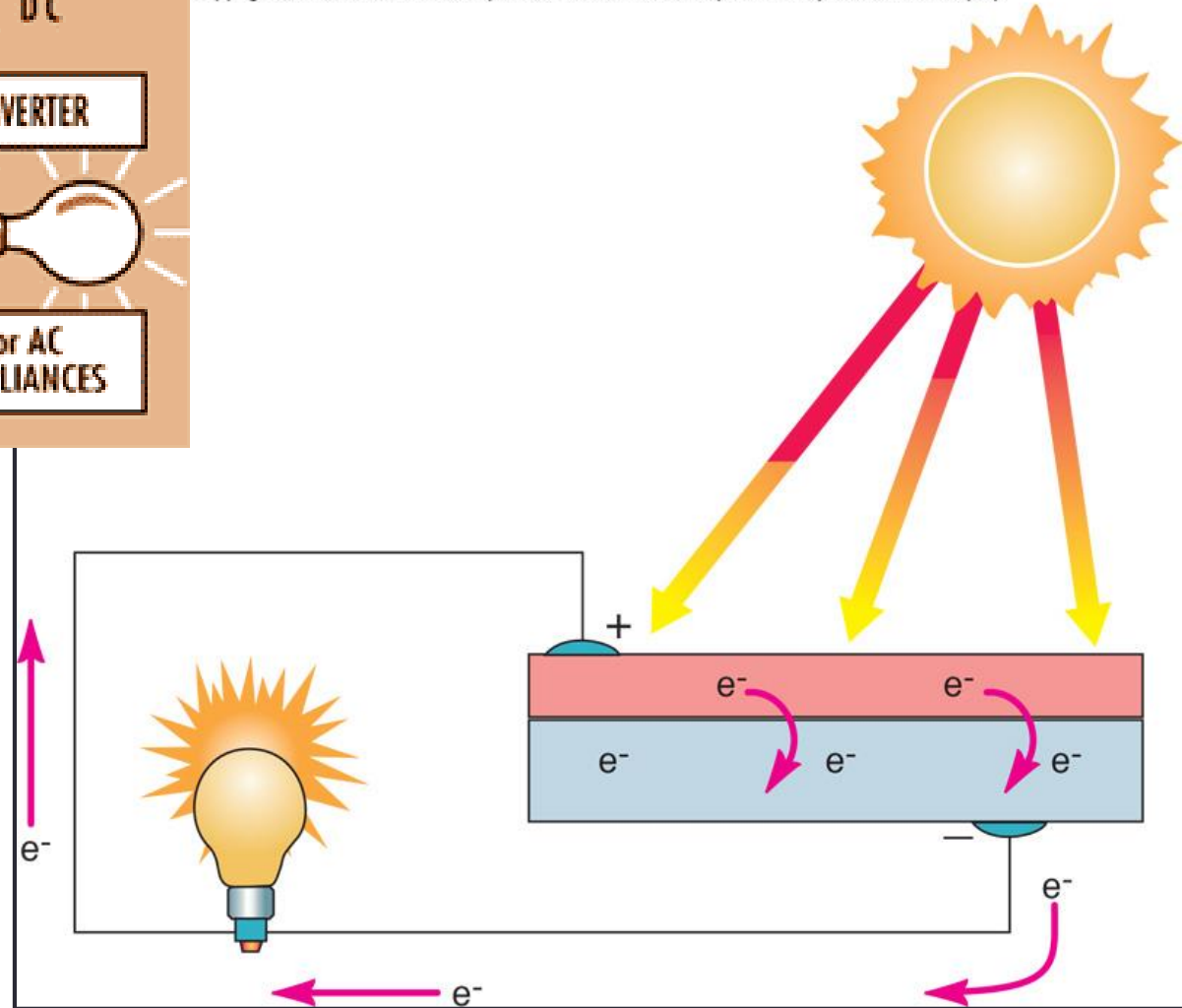
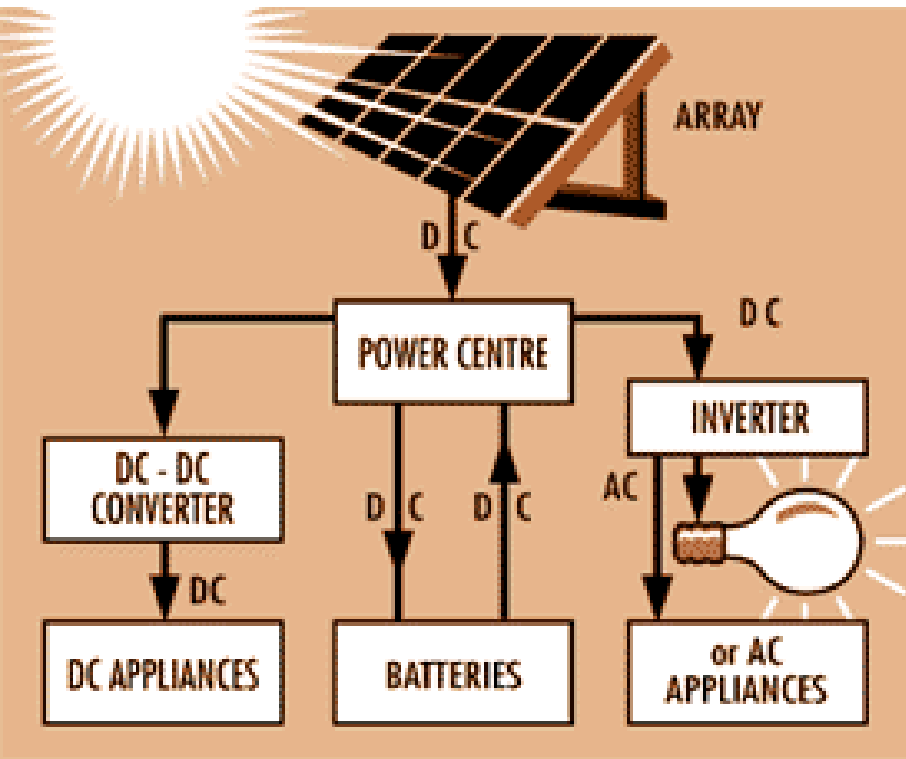
Photovoltaic Cells

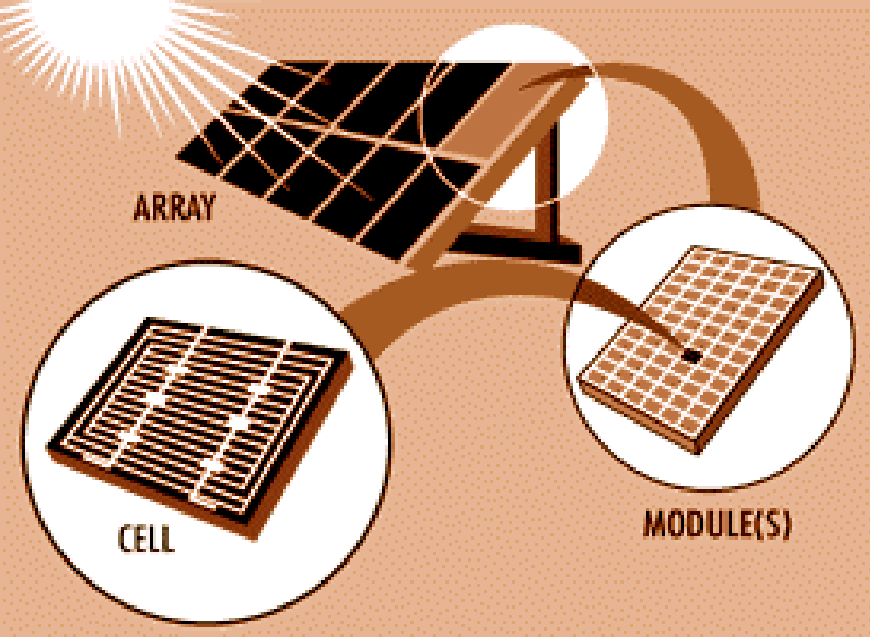
- Photovoltaic (PV) cells capture solar energy and convert it directly into an electrical current by separating electrons from their parent atoms and sending them across a one-way electrostatic barrier.
- No need to make steam because it bypasses the steam driven turbine generator.
- Cells are made of silicon. Contain no liquids, corrosives, moving parts. Require little maintenance other than hosing off the dust once in a while.
- These are what we put on houses, garages, etc.



Photovoltaic Systems

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Solar panels can be fitted onto existing roofs and structures.

Net Metering: residents do not need to store the energy on batteries because they can hook the system up to the electric meter box. The solar power is fed to the grid while the house draws electricity from the grid. The bill is the difference between the energy used and the energy made.

Net Metering: connects directly to meter. No battery required!



Solar Energy

Pros:

- The sun is renewable
- No mining waste
- No emissions
- Relatively easy maintenance
- As the cost of fossil fuels rises, solar decreases
- Do not need full sunlight every day. Germany produces most of its electricity from solar panels.
- [California Rebates](#) available
- [Low-interest loans](#) available

Cons:

- For the average consumer, the **upfront** costs of solar systems are still more expensive than fossil fuels.
- There are rebates, tax incentives, loans to help.
- You can RENT your rooftop with zero upfront cost to you.
- If net metering is not available in your area, you need battery storage.
- Large solar farms require that the land be excavated & leveled. Land is then covered by large solar arrays – cannot be used by wildlife or anyone else.

WIND ENERGY

Wind Energy

- Wind energy is captured using windmills
- By pushing on the blades, the wind actually turns the turbine which powers a generator and produces electricity.
- Wind energy bypasses the steam turbine generator (no need to boil water to turn a turbine).
- There are 3 wind farms in California: Palm Springs, Tehachapi, and Altamont Pass near San Francisco.
- Together, these three farms produce 1.5% of California's energy.



INSIDE OF A WIND TURBINE



Wind Energy

Pros:

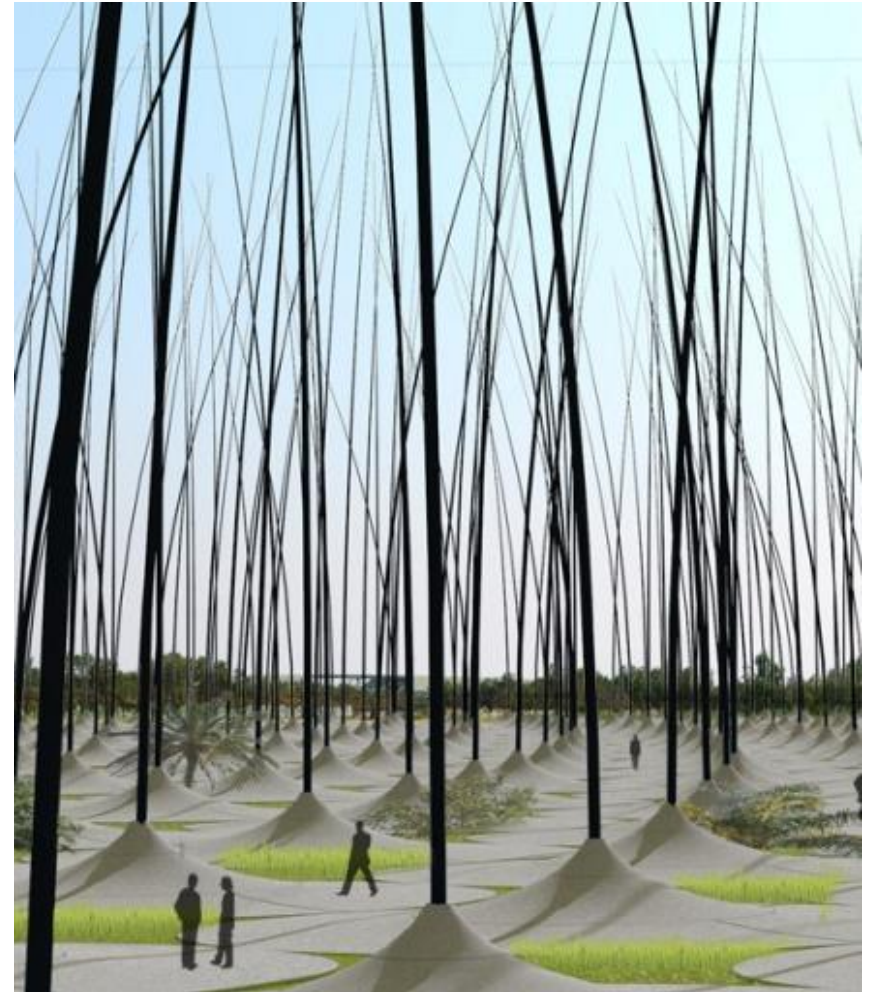
- Wind is renewable.
- No emissions.
- Land under the turbines is relatively untouched and can be used by wildlife or agriculture.
- There are many areas in the US that have consistent wind throughout the year, so there is a lot of room for this industry to grow.
- Cost per kilowatt hour is closer and closer to the less expensive kilowatt hour cost of fossil fuels.

Cons:

- [Wind turbines kill birds](#) & bats (see link). California's wind farms lie in major Pacific Flyway zones (western US bird migration path). Between 800 to 1,000 raptors are killed each year in Altamont Pass alone. Other species that migrate at night do not see the turbines.
- Modern turbine upgrades can significantly reduce these numbers. But installing them is costly.
- Potential wind farm areas need transmission lines.
- Wind farms require hundreds of acres of land.
- Since they are not aesthetically pleasing they tend to lower nearby property values.
- Require rare earth minerals to make the magnets inside the generators.

Wind Turbines without Blades?!

- A new generation of wind turbines may be hitting the market soon – these don't have blades, which means they won't take out the bats and birds that our current wind turbines do.
- Check out this link for more information – it's pretty cool! [Wind Stalks](#)

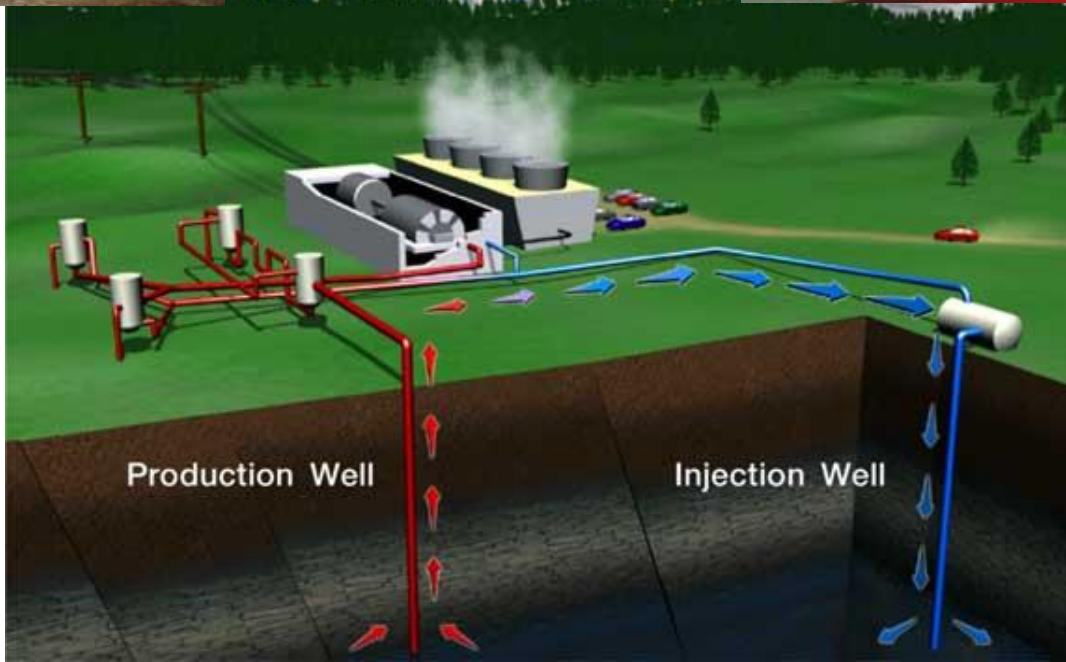
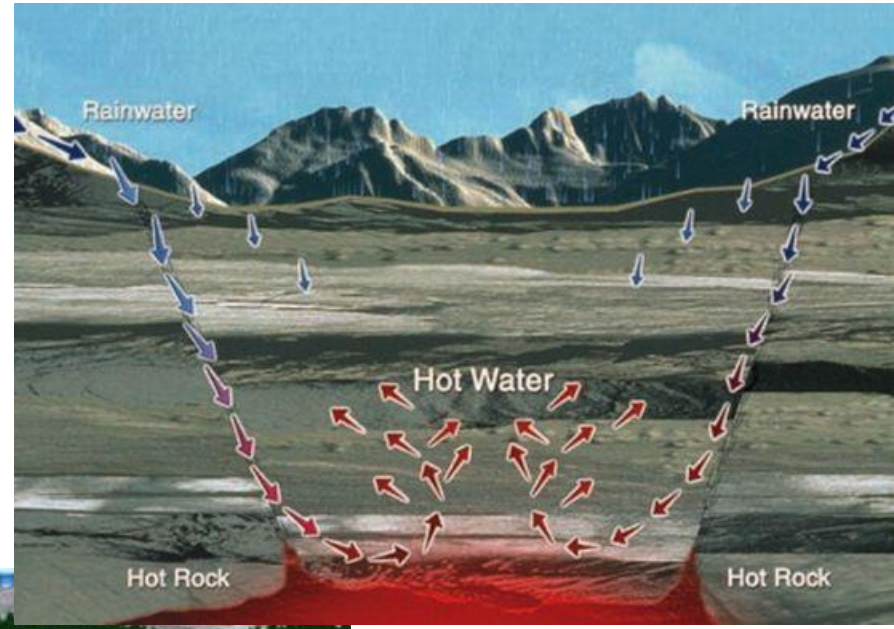


GEO THERMAL ENERGY

Geothermal Energy

- Uses heat from the interior of the Earth. This is the same energy which rises naturally to the Earth's surface in the form of hot springs, geysers, and volcanoes.
- Geothermal systems are located in areas where the Earth's crust is relatively thin as well as on the edges of continental plates.
- By drilling into the ground and inserting pipes, hot water or steam can be brought to the surface.
- Two ways to use the energy:
 - Heat is used to directly heat homes & businesses.
 - Steam is used to drive a turbine generator to make electricity in a power plant.

Geothermal



Geothermal

Pros:

- Relatively inexpensive because the energy plant can fuel itself.
- Plant site is less expensive to build than a fossil fuel plant because it is smaller and less equipment is needed.
- No emissions.
 - Exception: some harmful gases can be released, but these are contained fairly easily.

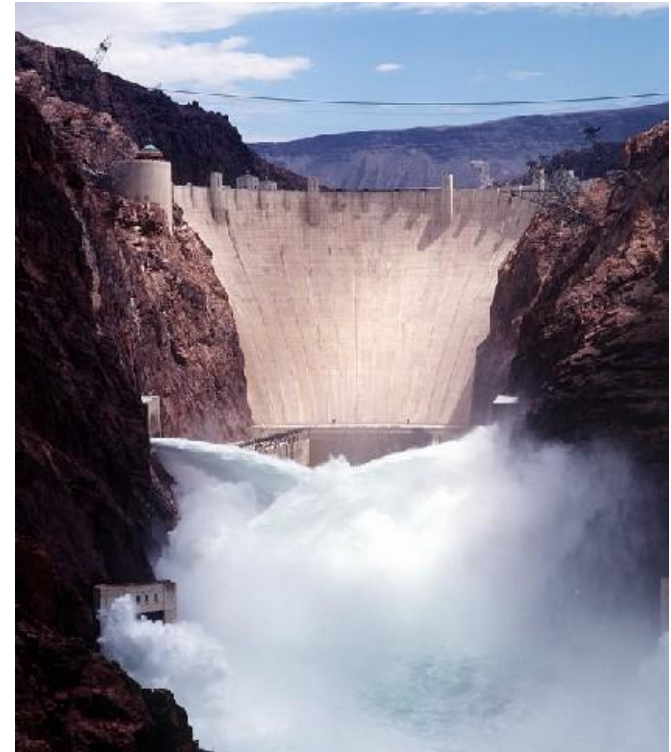
Cons:

- Finding a suitable site for a geothermal power plant is difficult:
 - How soft is the rock for drilling purposes?
 - Is the heat at that site hot enough?
 - How long will the heat at that site last?
 - Can the surrounding environment sustain a power plant?
- Dangerous gases from the earth's interior may be released when the deep wells are dug.

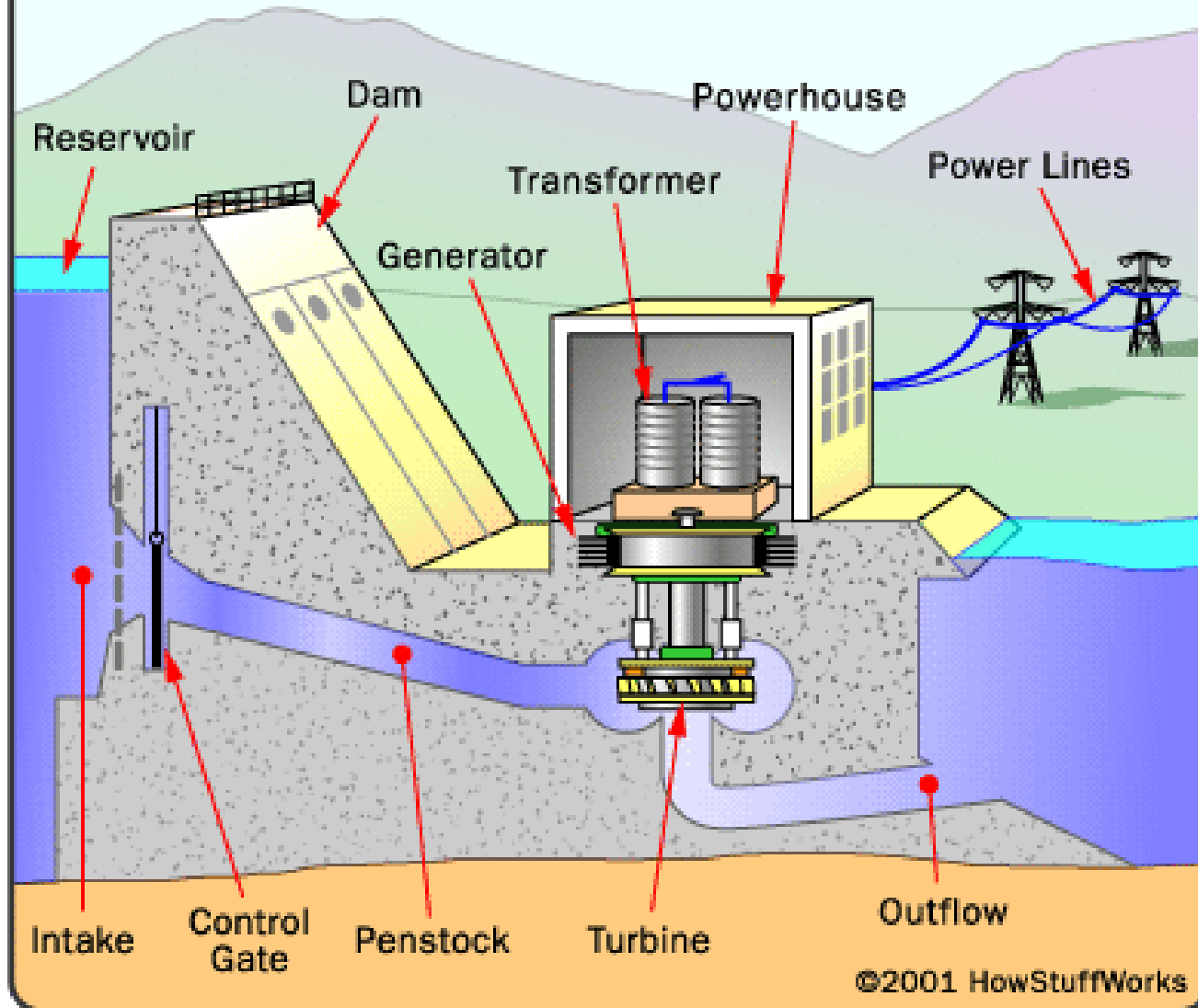
HYDROPOWER

Hydropower

- A reservoir of water is held behind a river dam. The water is periodically released to flow downstream.
- The force of the water flowing thru the dam is used to turn a turbine which powers a generator and produces electricity.
- Power lines carry the electricity to the power grid.



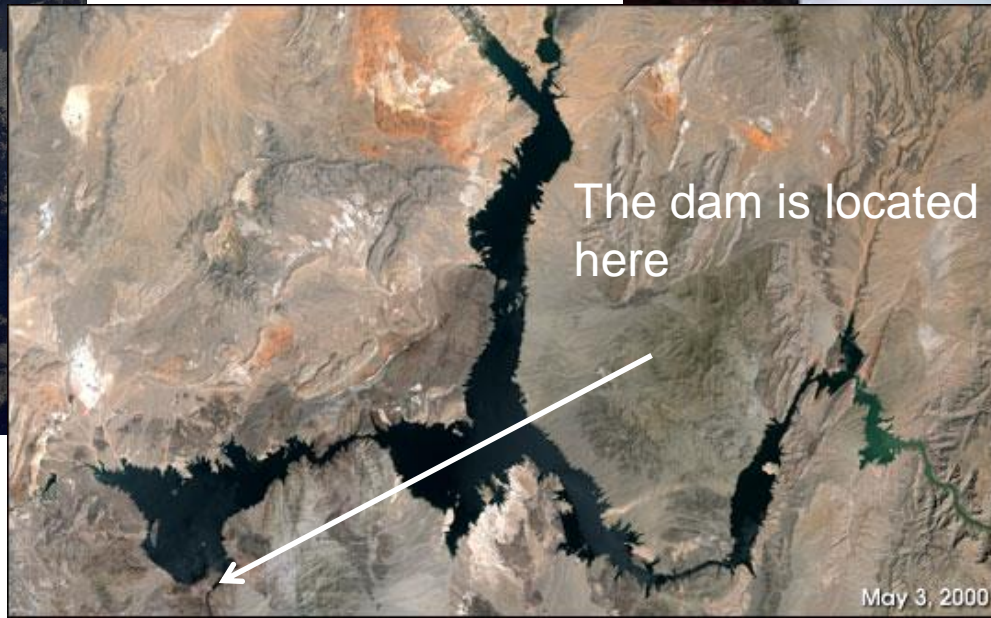
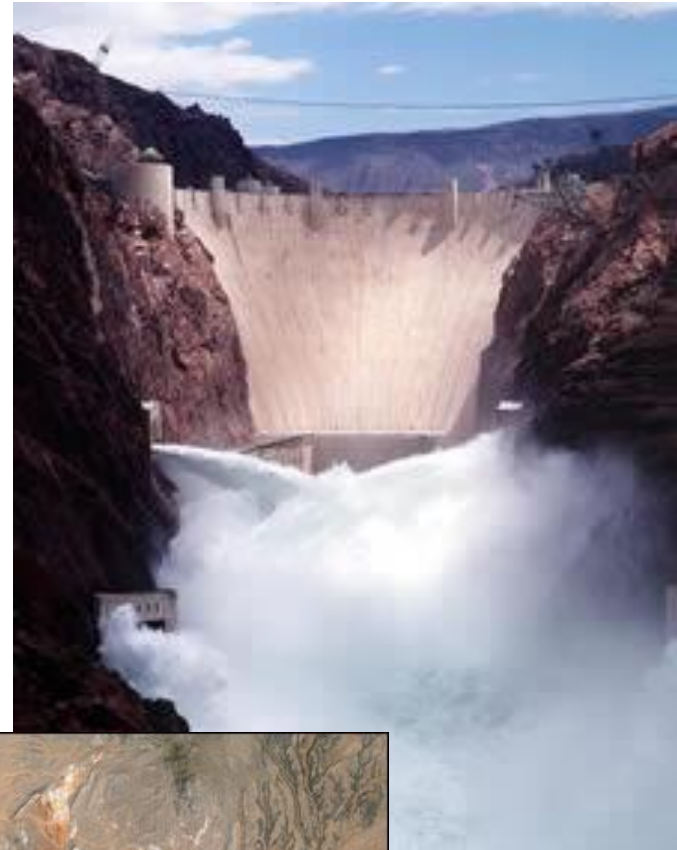
Inside a Hydropower Plant



Hoover Dam was built in 4 years – 1931-1935



Lake Mead is the largest man-made lake in the world. The Colorado River is currently at less than 50% capacity due to prolonged drought. This huge lake increases evaporation rate of the river water.



Hydropower

Pros:

- Inexpensive source of energy
- Does not require additional land because the turbine and generator are built into an existing dam.
- The reservoir provides recreational opportunities.
- Zero emissions.

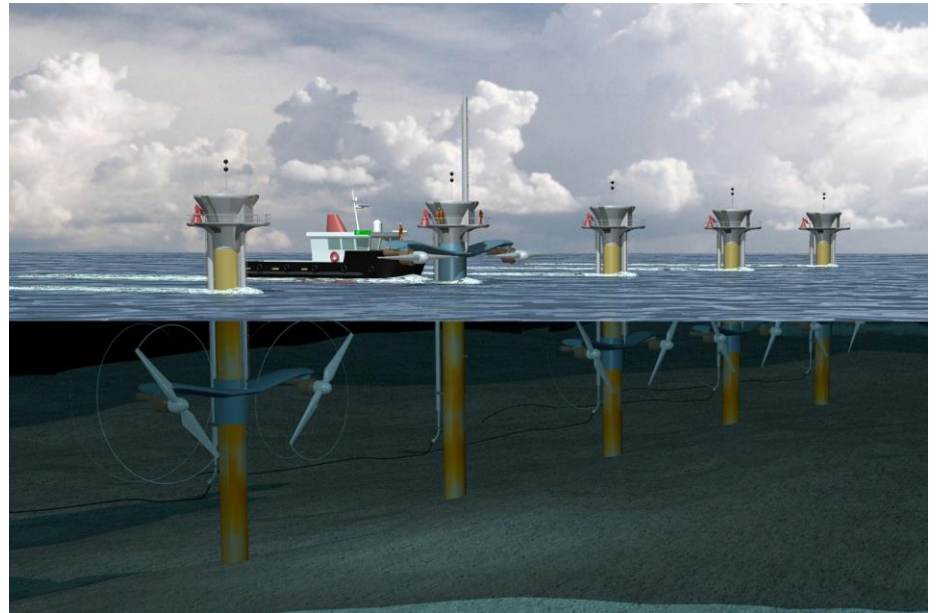
Cons:

- Very few sites available to expand hydropower as most rivers are already dammed or are protected from damming.
- Dams are ecologically destructive:
 - Dams stop natural river flow, which disrupts river ecology.
 - Disrupts fish migration.
 - Prevents natural flow of nutrients.
 - Permanently floods habitat upstream, which displaces both people and wildlife.
 - The released water scours the downstream portion because the force and amount is unnaturally high.
 - Build-up of silt and sediment.

TIDAL POWER

Tidal Energy

- Tides are caused by the gravitational force exerted by the moon and sun.
- Requires a dam or barrage across a tidal bay or estuary
- Expensive
- Environmental impacts different at each site depending on ecosystems etc.



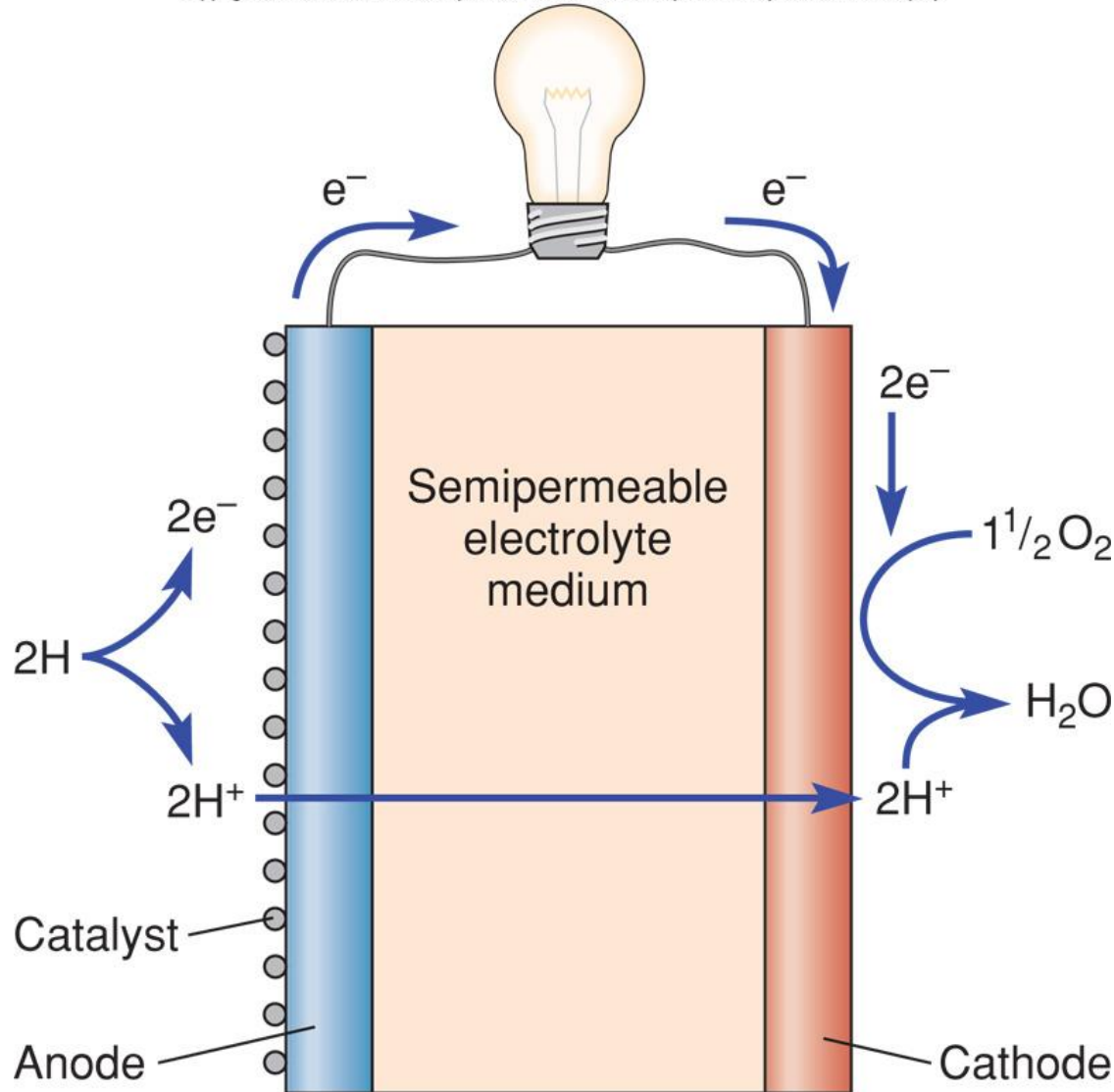
FUEL CELLS

Fuel Cells

- A fuel cell is a device that produces electricity from an electrochemical reaction.
- Hydrogen atoms are split apart and the flow of electrons creates an electric current while the protons are sent to the cathode.
- The electrons eventually meet back up with the protons and with oxygen. The by-product is water vapor.
- Fuel cells are used to power vehicles and buildings.

Fuel Cell

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Uses hydrogen - the most abundant element on earth.

By-products = water vapor and heat.

Efficiency = 40%-50%



Sunline Transit
Hydrogen bus

Honda Clarity – fuel cell



Fuel Cells

Pros:

- Uses hydrogen which the most abundant element on earth.
- Only water vapor emissions.
- No dangerous corrosives like those in batteries.
- Versatile: can be used to fuel automobiles and buildings.

Cons:

- Hydrogen must be stripped from compounds such as water and methane. It does not exist by itself.
- Fuel cell cars are potentially 80% efficient. However, since hydrogen is stripped from compounds, this process reduces the efficiency to 40-45%.
- Hydrogen is in a gaseous form. It is difficult to store on a car as it requires too much space. This reduces the distance that the car can be driven on one tank.
- No national infrastructure to supply hydrogen fuel to automobiles. It must be obtained from a special hydrogen fueling station.

BIOFUELS

Biofuels

- **Biodiesel** is a domestic, renewable fuel for diesel engines derived from natural oils like vegetable oil or animal fat.
- Ethanol is a grain alcohol produced from corn, sorghum, potatoes, wheat, sugar cane, and can even be produced from corn stalks and vegetable waste.
- When ethanol is combined with gasoline, it increases octane levels while also promoting more complete fuel burning that reduces harmful tailpipe emissions such as carbon monoxide and hydrocarbons.

“Biodiesel is made through a chemical process called [transesterification](#) ‘whereby the glycerin is separated from the fat or vegetable oil. The process leaves behind two products -- methyl esters (the chemical name for biodiesel) and glycerin (a valuable byproduct usually sold to be used in soaps and other products).’” ([NBB](#))

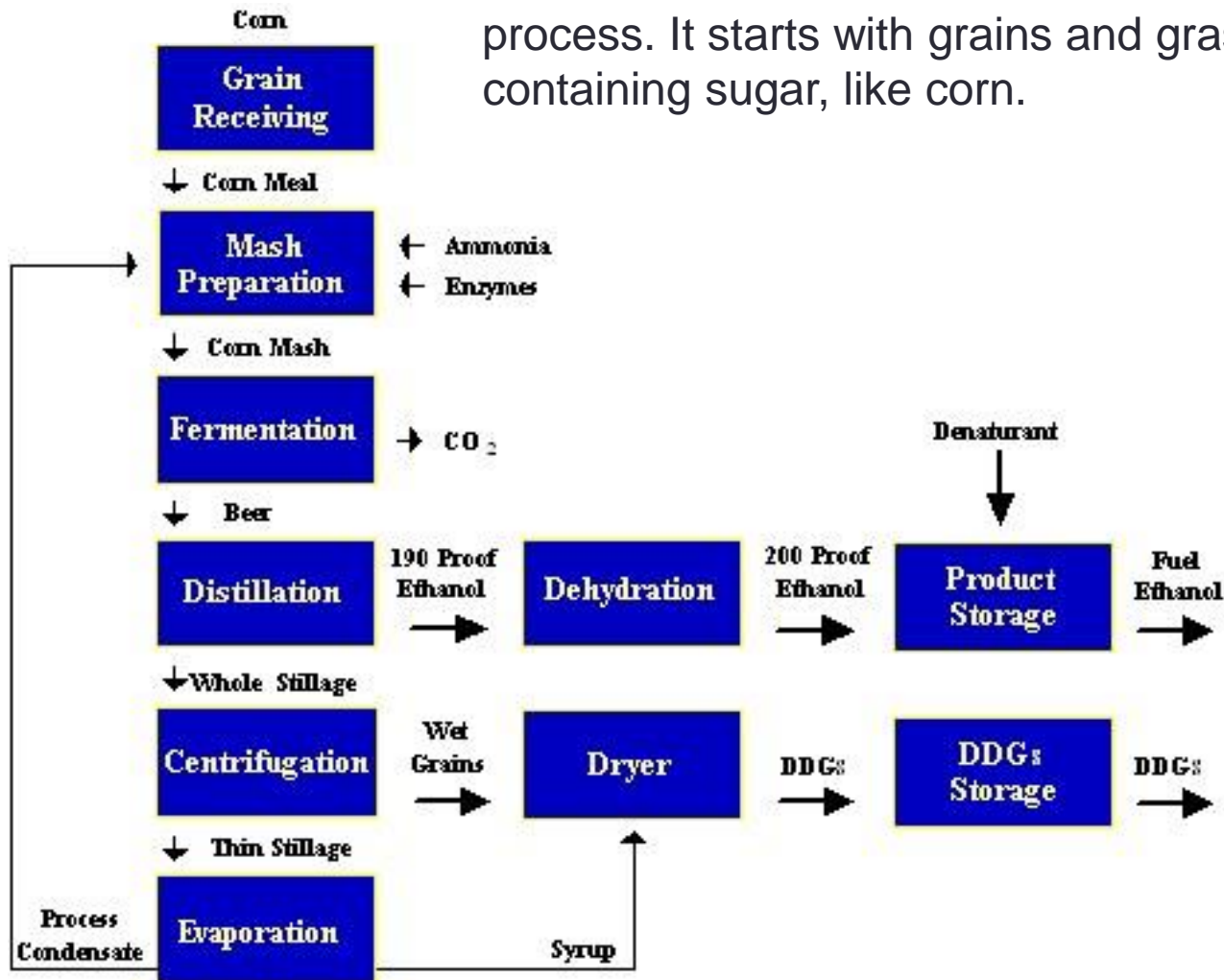


You can use fry oil and used vegetable oil to make biodiesel = recycling!



HOW ETHANOL IS MADE

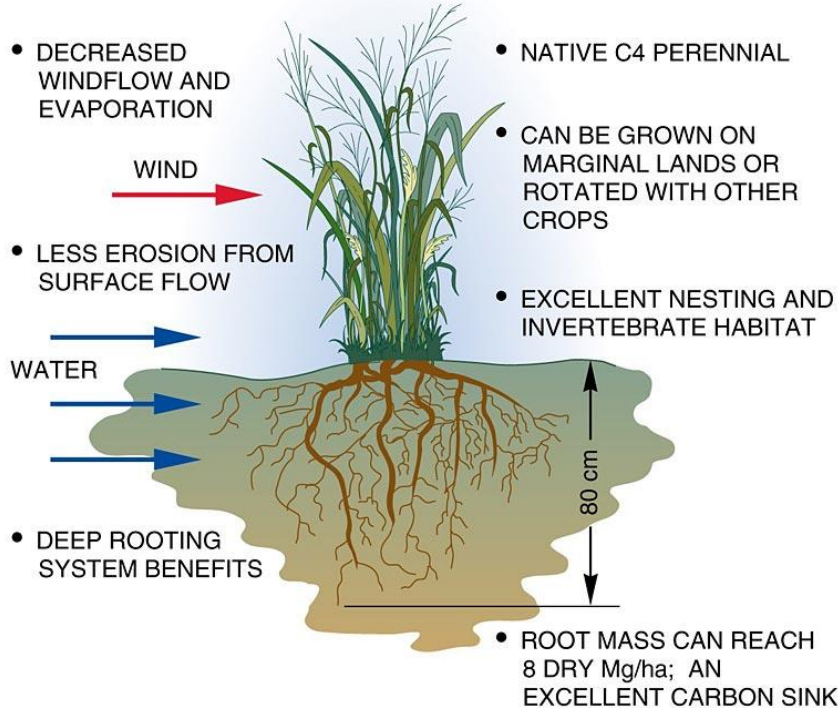
Ethanol is derived from a fermentation process. It starts with grains and grasses containing sugar, like corn.



SWITCHGRASS CAN ALSO BE USED TO MAKE ETHANOL & HAS ADDED BENEFITS

ORNL-DWG 93M-8892

SWITCHGRASS



From Algae to “Oilgae”



An oil alternative

Kertz, a plant physiologist, developed a system using 10-foot-long water-filled plastic bags suspended in a greenhouse-like setting in the desert to grow algae, from which vegetable oil can be extracted to produce biodiesel.



Glen Kertz, right, Chief Executive Officer of Valcent Products, Inc. and business partner Doug Frater, President and CEO of Global Green Solutions stand by their algae bioreactors. (Rudy Gutierrez/El Paso Times)

Biofuels

Pros:

- Reduces need for oil.
- Much cleaner emissions.
- Can be blended with fossil fuel and result in more complete combustion and better gas mileage.
- Can use waste matter to make fuel.
- Can grow native switchgrass for ethanol in certain climate zones.
 - Adds nutrients to the soil
 - Provides habitat for species
 - Tight root structure reduces erosion

Cons:

- Converting the fuel source into fuel requires almost as much energy as the final output.
- Ethanol cannot be an equal substitute for gas because there is not enough land in the US to grow the necessary corn (unless we use switchgrass)
- Major losses of habitat to grow more sugar cane and corn (especially in Brazil).
- Monocropping: farmers want to only grow corn for ethanol or soy for biodiesel which depletes soil nutrients and causes erosion.

FUSION

Fusion Power

- Energy is generated by using [fusion reactions](#) to produce heat for electricity generation.
- Fusion of two lighter atomic nuclei to form a heavier nucleus, releasing energy.
- **Fusion reactors** harness this energy

Fusion Power

Pros (theoretical):

- Less radioactivity than fission.
- Ample fuel supplies.
- Safer than fission.
- No emissions

Cons:

- Controlled fusion has proven to be extremely difficult to produce in a practical and economical manner.
- Research into fusion reactors began in the 1940s, but as of 2017, no design has produced more fusion energy than the energy needed to initiate the reaction, meaning all existing designs have a negative energy balance

Examples of Government Incentives

- Imposition of higher fuel economy standards (54.5 mpg by 2025)
- Tax incentives for insulation, windows, doors, appliances etc.
- Phase out of incandescent light bulbs
- Raised energy efficiency standards for appliances
- Investment in more efficient electricity distribution
- Improvement in high speed rail transportation



Conclusion

- At this time alternative energy cannot provide for all of the world's energy needs, as we have not installed the infrastructure to do so.
- The most effective and necessary solution is to reduce energy consumption.
- The next most effective and necessary solution is to support alternative energy research and infrastructure installation so that we can use it on a larger scale.

