

*Climb the mountains
and get their good
tidings. Nature's
peace will flow into
you as sunshine flows
into trees, The winds
will blow their own
freshness into you and
the storms their
energy, while cares
will drop away from
you like the leaves of
autumn.*

- John Muir

TOPICS INCLUDE:

- Renewable Energy
- Energy Conservation

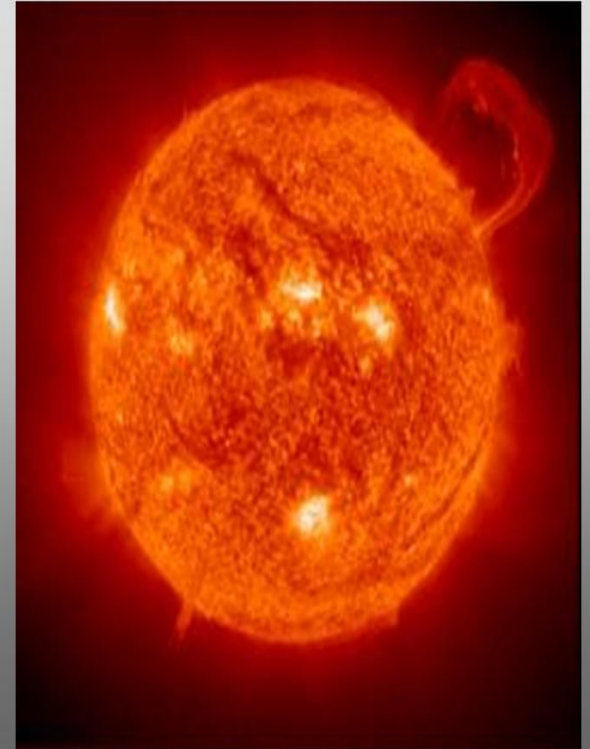
AP ENVIRONMENTAL SCIENCE

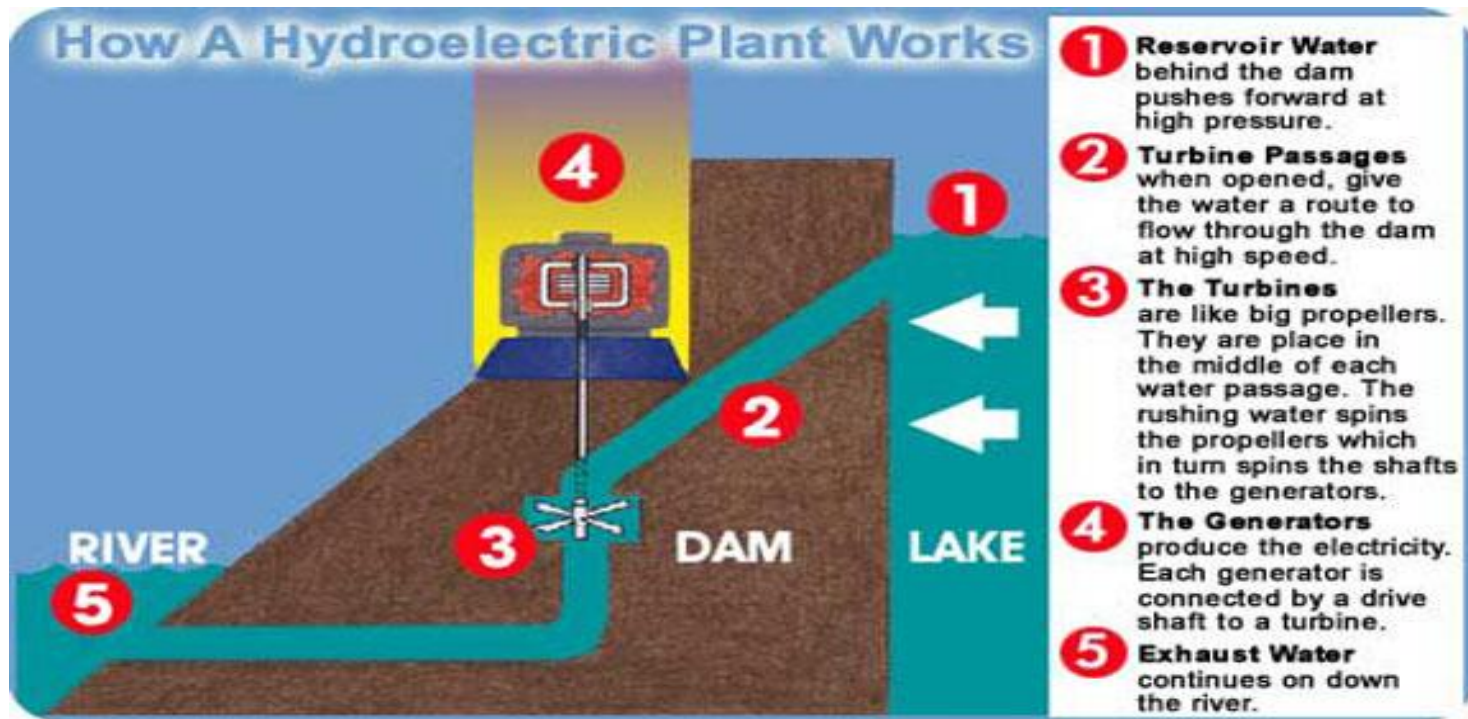


UNIT 5: ENERGY RESOURCES AND CONSUMPTION (PART B)

V. ENERGY RESOURCES AND CONSUMPTION (10-15%)

- A. **Energy Concepts** – energy forms, power units, conversions, and laws of thermodynamics
- B. **Energy Consumption** – History (Industrial Revolution, exponential growth, and energy crisis), Present global energy use, future energy needs
- C. **Fossil Fuels Resources and Use** – formation of coal, oil, and natural gas, extraction/purification methods, world reserves and global demand, synfuels, and environmental advantages/disadvantages of sources
- D. **Nuclear Energy** – nuclear fission process, nuclear fuel, electricity production, nuclear reactor types, environmental advantages/disadvantages, safety issues, radiation and human health, radioactive waste and nuclear fusion
- E. **Hydroelectric Power** – dams, flood control, salmon, silting and other impacts
- F. **Energy Conservation** – energy efficiency, CAFÉ standards, hybrid electric vehicles, and mass transit
- G. **Renewable Energy** – solar energy, solar electricity, hydrogen fuel cells, biomass, wind energy, small-scale hydroelectric, ocean waves and tidal energy, geothermal and environmental advantages/disadvantages





- Dams are built to trap water
- When water is released it is channeled through turbines that generate electricity
- Supplies about 10% electricity in US; 3% worldwide
- Water Resources Development Act (1986):
Established dam safety programs & standards

HYDROELECTRIC POWER

| PROS | CONS |
|------------------------------------|--|
| Dams control flooding | Dams create flooded areas behind the dam which people are displaced. Water is slow moving & can breed pathogens. |
| Low operating & maintenance costs | Dams destroy wildlife habitats & keep fish from migrating |
| No polluting waste products | Sedimentation requires dredging. Prevents sedimentation from reaching downstream & enriching farmland. |
| Long life spans | Expensive to build |
| Moderate to high net-useful energy | Destroys wild rivers |
| Areas of water recreation | Large-scale projects are subject to earthquakes |

FLOOD CONTROL

◉ Channelization

- Straighten & deepen streams
- Removes bank vegetation & increase stream velocity which can cause erosion
- May increase downstream flooding & sedimentation, which negatively impacts aquatic ecosystems

◉ Dams

- Store water in reservoirs
- During excessive rains; excess water may need to be released

◉ Identify & Maintain Flood-Prone Areas

- Precautionary building practices (building elevation, flood-ways, and pumping stations)

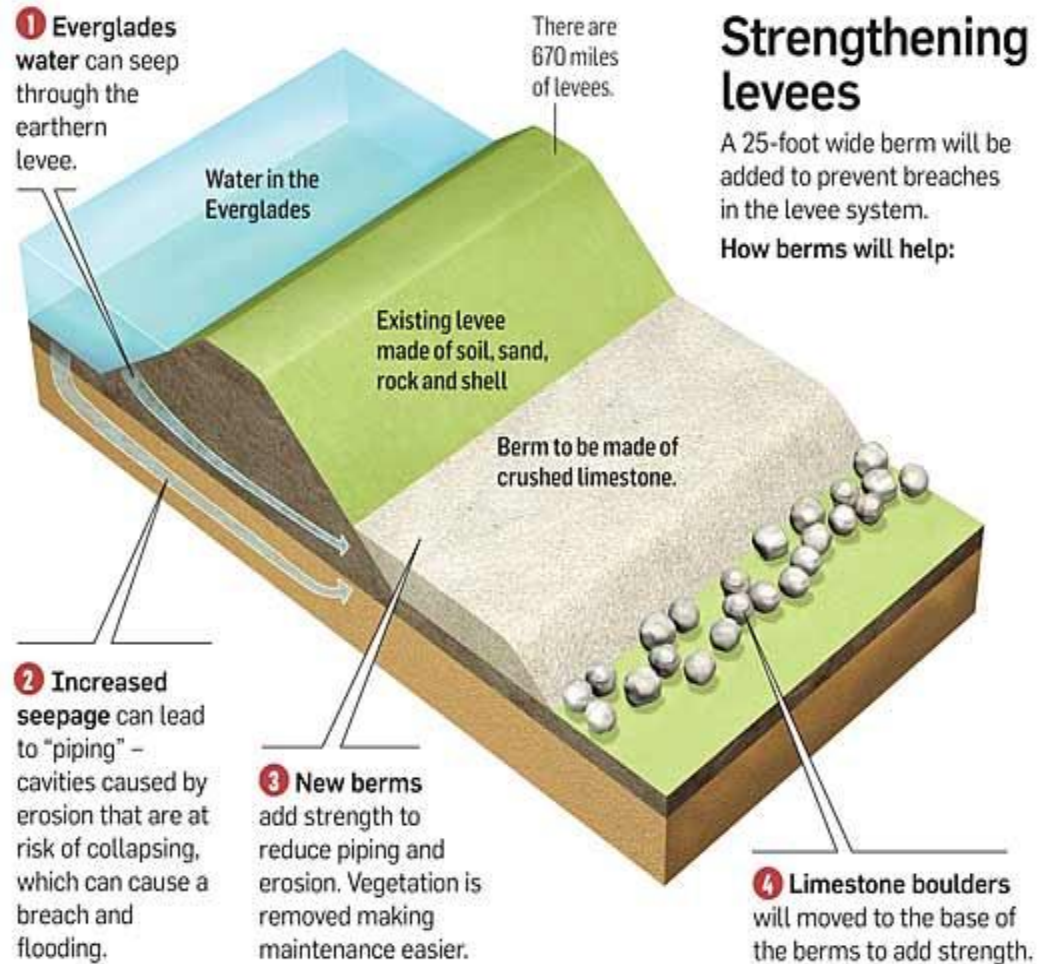
FLOOD CONTROL (CONT.)

Levees or Flood Walls

- Raised embankments to prevent a river from overflowing
- Contain river & stream flows but increase water velocity
- Can break (Katrina 2005, New Orleans)

Preserve Wetlands

- Protect natural flood plains & maintain biodiversity



DAMS EFFECTS ON SALMON

- ◉ Estimated 74,993 dams in America blocking 600,000 miles of what once was free-flowing rivers
- ◉ Salmon are migratory fish that hatch in streams & rivers and then swim downstream to the ocean to live most of their lives
- ◉ Return to rivers & stream to spawn
- ◉ Dams have destroyed spawning & hatching habitats for salmon
- ◉ 106 major salmon runs are extinct, & 25 more are endangered



SOLUTIONS: SAVING THE SALMON

- Fish passage facilities & fish ladders that help juvenile & adult fish migrate over or around many dams
- Spilling water at dams over the spillway helps pass juvenile fish downstream because it avoids sending the fish through the turbine



SILTING & OTHER IMPACTS

- ◉ Disease

- In tropical areas, dam reservoirs are breeding grounds for mosquitoes, snails & flies (vectors that carry malaria, schistosomiasis & river blindness)

- ◉ Displacement

- Flooded areas behind dams destroy rich croplands and displace people

- ◉ Effects on Watershed

- Downstream areas are deprived of the nutrient-rich silt that revitalize depleted soil profiles

- ◉ Impact on Wildlife

- Migration & spawning cycles are disrupted

- ◉ Silting

- When silt that is dissolved in rivers settles out behind dams. Over time silt builds up & must be removed (dredged)

- ◉ Water Loss

- Large losses of freshwater occur through evaporation & seepage through porous rock beds.

ENERGY CONSERVATION

- ◉ Joint program of the US Environmental Protection Agency and US Department of Energy
- ◉ Protects the environment through energy-efficient products & practices
- ◉ Save enough energy in 2005 to avoid greenhouse gases equivalent to 23 million cars and \$12 billion in utility bills.



CAFE STANDARDS

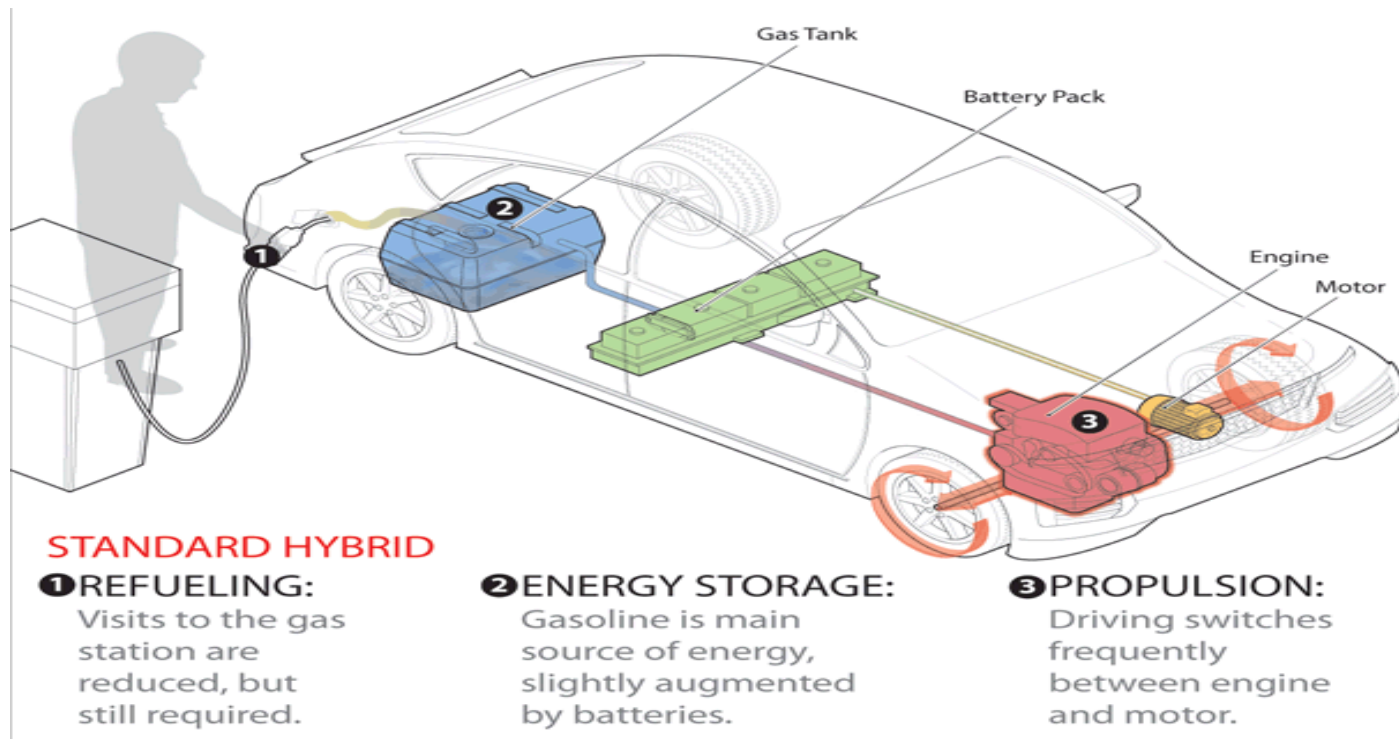
CORPORATE AVERAGE FUEL ECONOMY



“Transportation needs consume 2/3 of the petroleum consumption in the US”

- The average fuel economies of a manufacturer’s fleet of passenger cars or light trucks
- Saving of over 55 billion gallons of fuel annually with a reduction in CO₂ emissions of about 10%
- Achieved through better engine design, efficiency, and weight reduction

HYBRID ELECTRIC VEHICLES



- ◉ Produces almost no pollution
- ◉ Smaller gasoline engine
- ◉ Fuel tank is the energy storage device
- ◉ Advanced electronics allow electric motor to act as generator
- ◉ Generators produces electrical power
- ◉ Batteries act as the energy storage device

SOLAR ENERGY

- ◉ Collecting & harnessing radiant energy from the sun to provide heat and/or electricity
- ◉ Can be generated at home and industrial sites through photovoltaic cells or solar collectors or at a central solar-thermal plant
- ◉ Active solar collectors: use the sun's energy to heat water or air inside a home or business; requires electrical input (pumps & fans)
- ◉ Passive solar: requires no moving parts; the structure is built to maximize solar capture (large, south-facing windows)
- ◉ Photovoltaic cells are used to generate electricity

Making electricity from the sun's heat

Concentrated solar power

A field of tracking mirrors focuses sunlight onto a glass receiver containing water that can be heated to over 750° F.

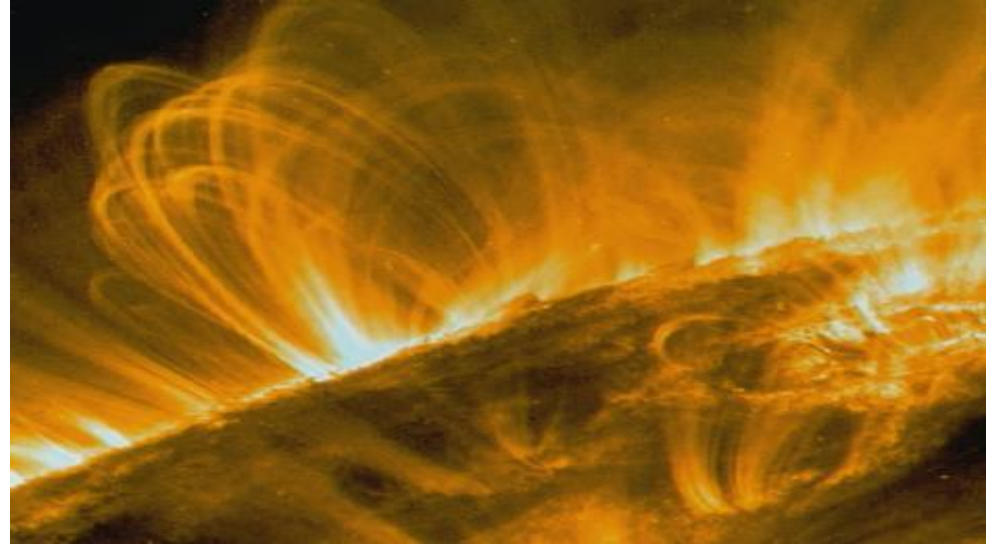
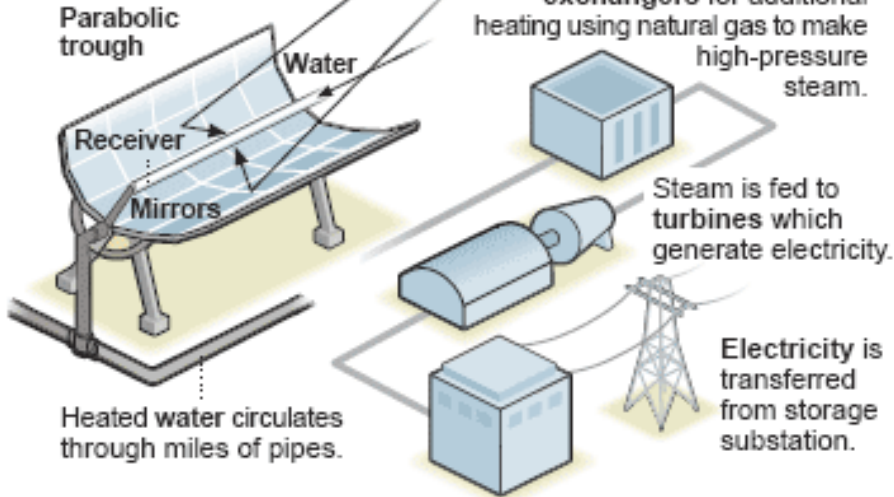


The sun's reflected radiation intensifies 30 to 100 times on receiver.

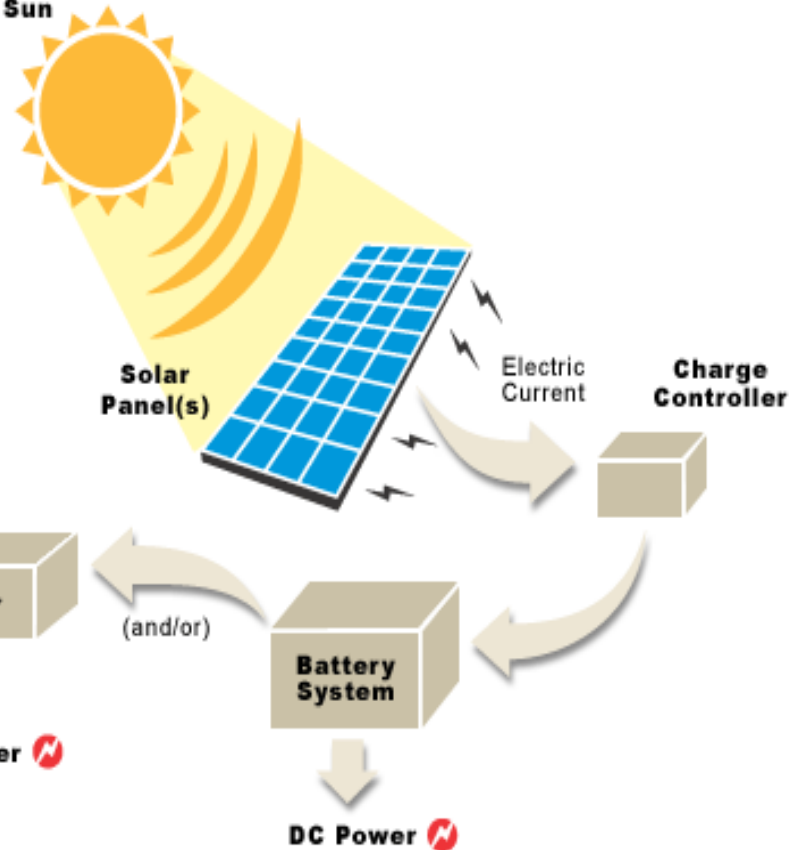
Water passes to heat exchangers for additional heating using natural gas to make high-pressure steam.

Steam is fed to turbines which generate electricity.

Electricity is transferred from storage substation.



Solar Irradiance from the Sun



SOURCES: Energy Information Administration; Schott Corporation AP

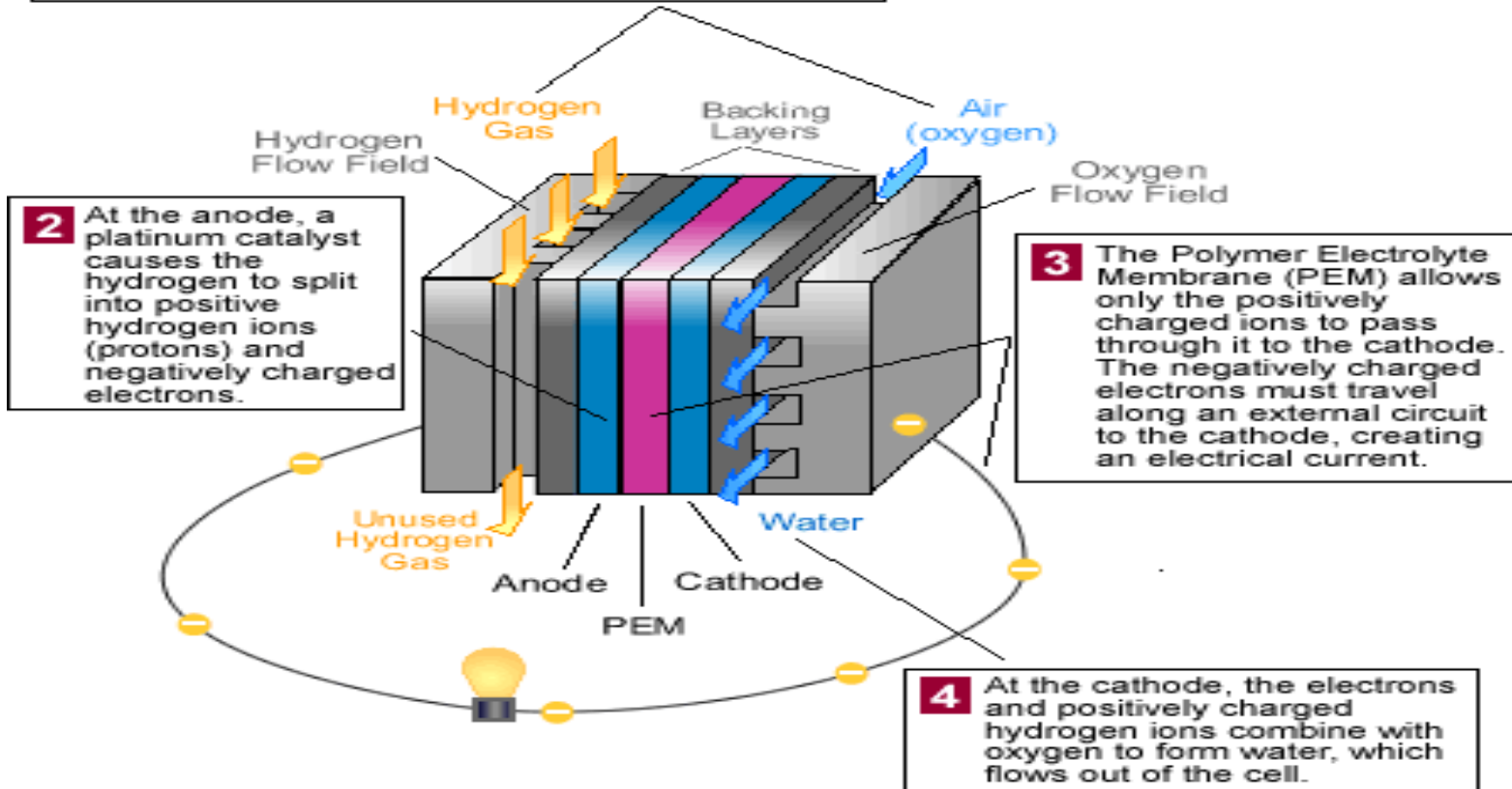


SOLAR ENERGY

| PROS | CONS |
|---|--|
| Supply of solar energy is limitless | Inefficient where sunlight is limited or seasonal |
| Reduces reliance on foreign imports | Maintenance costs are high |
| Only pollution is in manufacture of collectors (little environmental impact) | Systems deteriorate & must be replaced periodically |
| Can store energy during the day & release it at night (good for remote locations) | Current efficiency is b/w 10-25% and not expected to increase soon |

HYDROGEN FUEL CELLS

1 Hydrogen fuel is channeled through field flow plates to the anode on one side of the fuel cell, while oxygen from the air is channeled to the cathode on the other side of the cell.

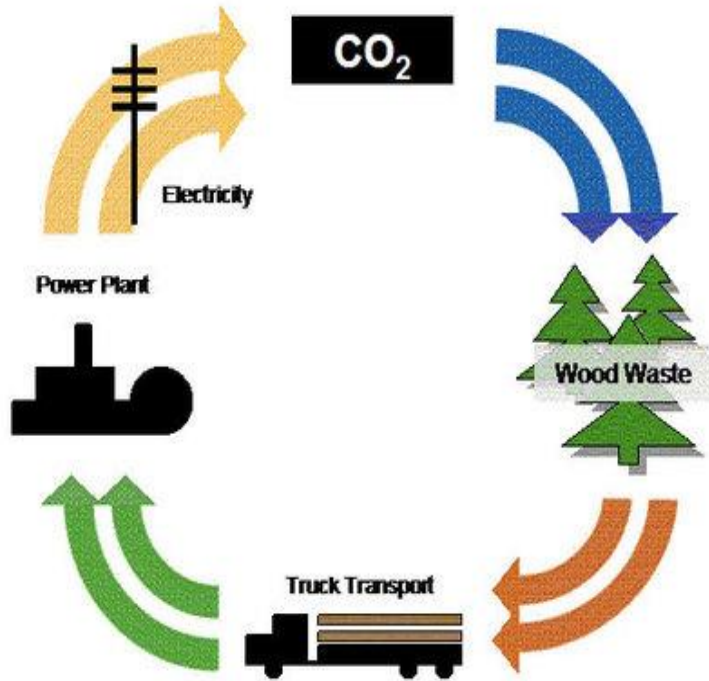


- ◉ 9 million tons of hydrogen is produced in US each day (can power 20 to 30 million cars to 5 to 8 million homes)
- ◉ Operate similar to battery
- ◉ Unlike batteries fuel cells never run out

HYDROGEN FUEL CELLS

| PROS | CONS |
|---|---|
| Waste product is pure water | Takes energy to produce the hydrogen from either water or methane |
| Ordinary water (ocean & freshwater) can be used to obtain hydrogen | Changing from a current fossil fuel system to a hydrogen-based system would be very expensive |
| Does not destroy wildlife habitats & has minimal environmental impacts | Hydrogen gas is explosive |
| Energy to produce hydrogen could come from fusion reactor, solar , or other less-polluting source | At the current time, it is difficult to store hydrogen gas for personal cars |
| Hydrogen is easily transported through pipelines | |
| Hydrogen can be stored in compounds to make it safe to handle | |

BIOMASS



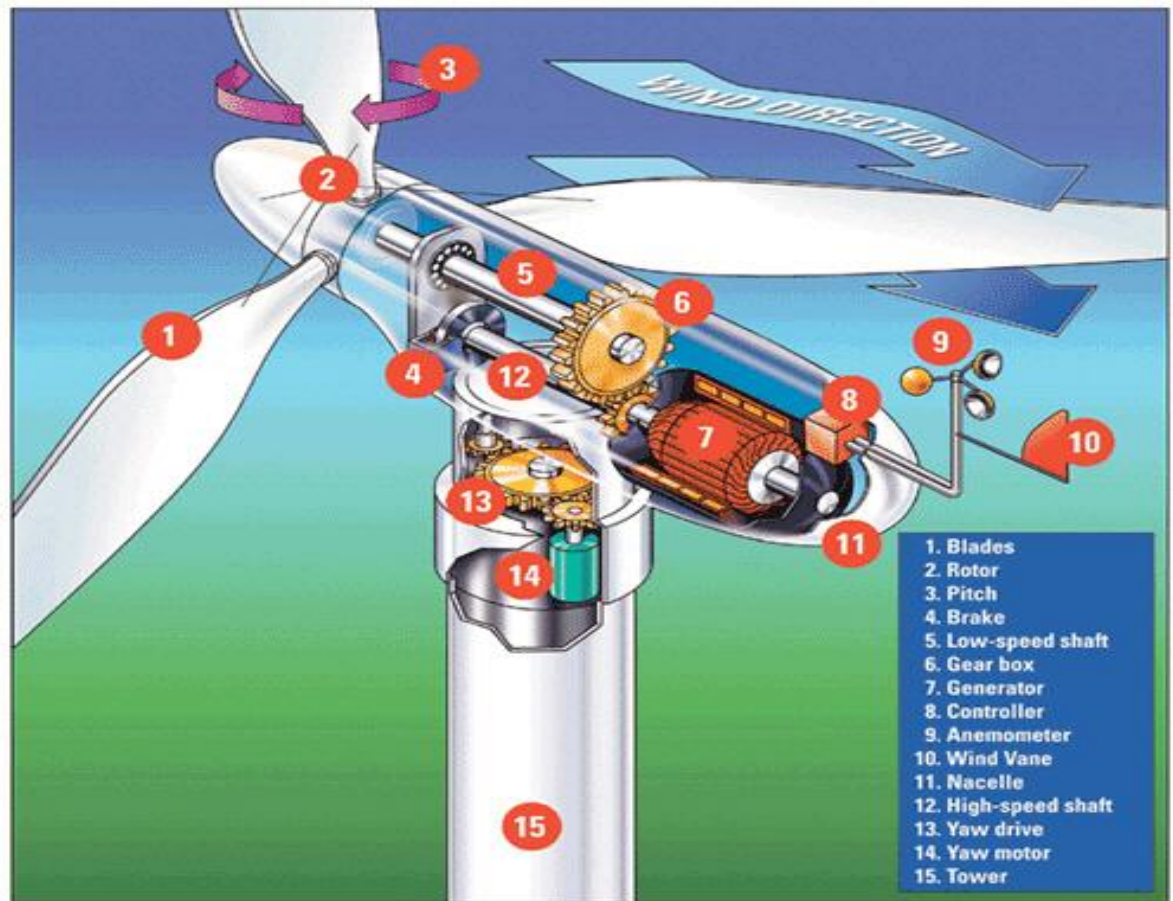
- Any carbon-based, biologically derived fuel source as wood, manure, charcoal grown for use as a biofuel (biodiesel, methanol, ethanol)
- Plants suitable are switch grass, hemp, corn, & sugarcane
- Can be used for building materials & biodegradable plastics & paper
- Approximately 15% of the world's energy
- Most commonly used in developing countries

BIOMASS

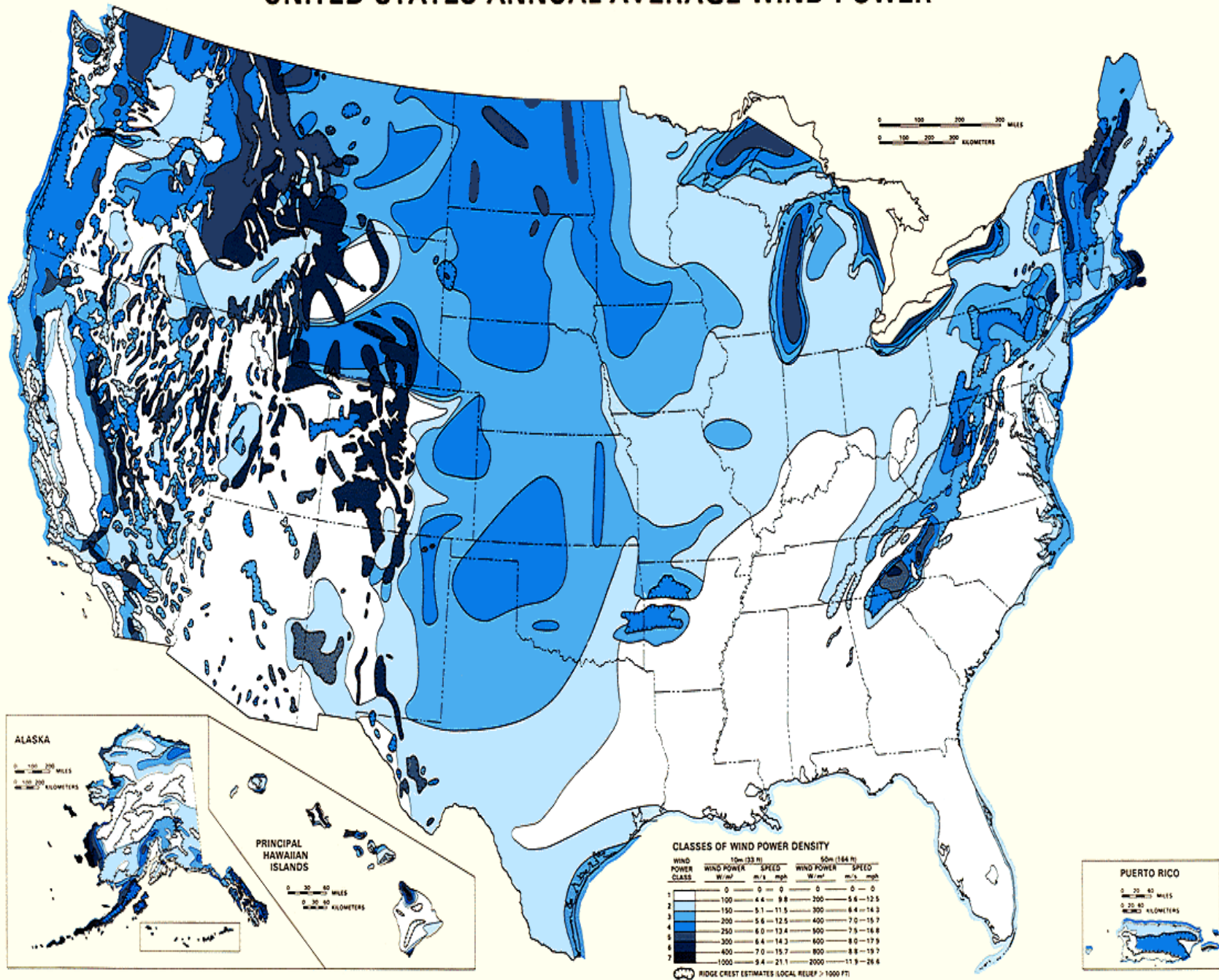
| PROS | CONS |
|--|---|
| Renewable energy source as long as used sustainably | Requires adequate water & fertilizers, of which sources are declining |
| Rates of use balanced with rate of renewal does not disrupt atmospheric CO ₂ levels | Use of inorganic fertilizers, herbicides, & pesticides would harm environment |
| Less SO ₂ and NO _x produced than by burning fossil fuels | Would cause massive deforestation & loss of habitat, resulting in a decrease in biodiversity |
| Can be sustainable if issue of deforestation & soil erosion are controlled | Inefficient methods of burning biomass would lead to large levels of air pollution, especially particulate matter |
| Could supply half of the world's demand of electricity | Expensive to transport because it is heavy |
| | Not efficient; about 70% of the energy derived from biomass is lost as heat |

WIND ENERGY

- ◉ Wind turns giant turbine blades that then power generators
- ◉ Turbines can be grouped in clusters called wind farms



UNITED STATES ANNUAL AVERAGE WIND POWER



WIND ENERGY

PROS

All electrical needs of the US could be met by wind in North Dakota, South Dakota & Texas

Wind farms can be quickly built and can also be built on sea platforms

Maintenance is low & the farms are automated

Moderate to high net-energy yield

No pollution, Wind farms are in remote areas so noise pollution is minimal

Land underneath wind turbines can be used for agriculture (multi-use)

CONS

Steady wind is required to make investment in wind farms economical (few places suitable)

Backup systems need to be in place when the wind is not blowing

Visual pollution

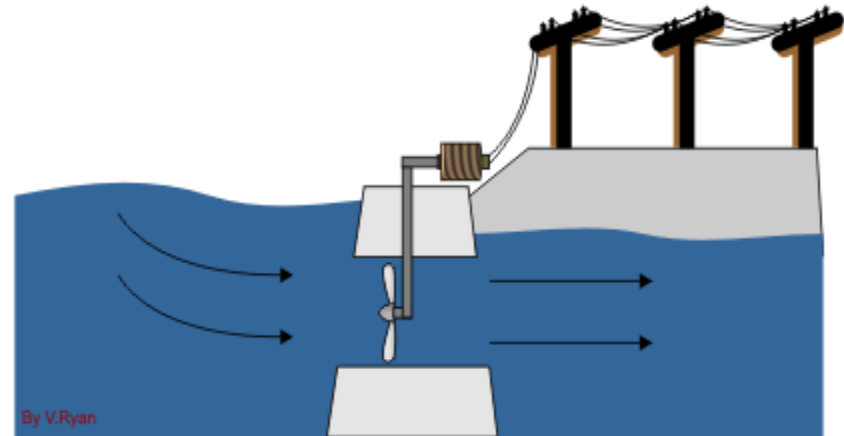
May interfere with flight patterns of birds

May interfere with communications, such as microwaves, TV & cell phones

Noise pollution

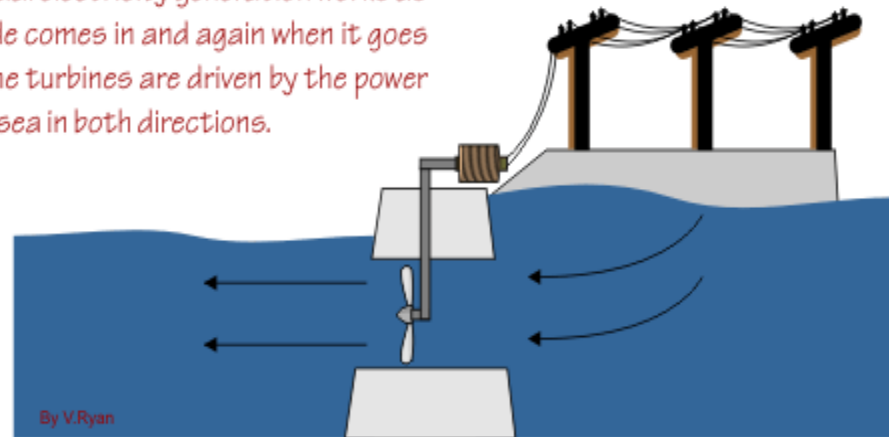
OCEAN WAVES & TIDAL ENERGY

- Natural movement of tides & waves spin turbines that generate electricity
- Only a few plants worldwide (North coast of France & Bay of Fundy between Canada & US)



TIDE COMING IN

This tidal electricity generation works as the tide comes in and again when it goes out. The turbines are driven by the power of the sea in both directions.



TIDE GOING OUT

WAVES & TIDAL ENERGY

| PROS | CONS |
|------------------------------|--|
| No pollution | Construction is expensive |
| Minimal environmental impact | Few suitable sites |
| Net-energy yield is moderate | Equipment can be damaged by storms & corrosion |



GEO THERMAL ENERGY

- ◉ Heat contained in underground rocks & fluids from molten rock (magma), hot dry-zones, & warm-rock reservoirs produce pockets of underground steam, wet steam & hot water
- ◉ Steam used to drive turbines, which generate electricity
- ◉ Supplies less than 1% of the energy needs in the US
- ◉ Hawaii, Iceland, Japan, Mexico, New Zealand, Russia & California
- ◉ Tend to follow tectonic plate boundaries

PROS:

- Moderate net-energy yield
- Limitless & reliable source if managed properly
- Little air pollution
- Competitive cost

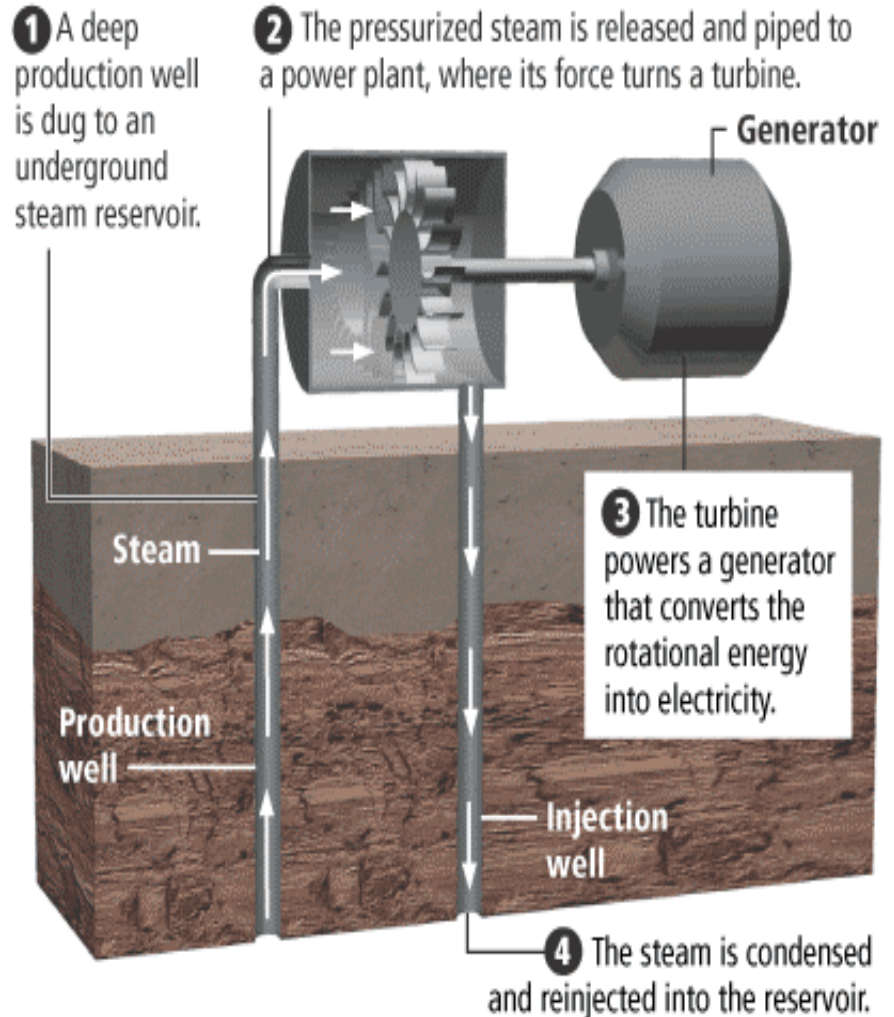
CONS:

- Reservoirs sites are scarce
- Source can be depleted if not managed properly
- Noise, odor, land subsidence
- Can degrade ecosystem due to corrosive, thermal, or saline waters

HARNESSING GEOTHERMAL ENERGY

Geothermal power could theoretically satisfy all the world's energy needs. Trouble is, it's expensive to do the deep drilling necessary to tap the heat.

HOW IT WORKS



VIDEO

- RENEWABLE ENERGY

<http://videos.howstuffworks.com/hsw/19079-exploring-energy-renewable-resources-video.htm>