

Goal 2.2

Sustainability

Ensuring the Ability to Live
Sustainably on Earth!

Sustainability – A Definition...

Sustainability – continued survival – using energy and material resources to maintain survival for the present and the future

Lesson 1

Traditional Energy Sources

Think About It...

Which two sources of
traditional energy do YOU use
the most?

Focus Question...

How do we obtain traditional energy sources and what effect does that have on the environment?

Traditional Energy Sources...

Wood...

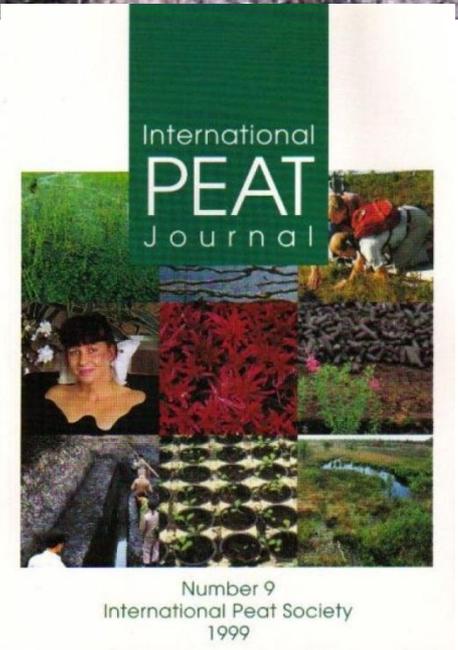
- renewable
- trees (might include crop residue)
- heating and cooking
 - 1.5 billion people use this energy source
 - mostly in developing countries
 - the most ancient form of fuel!
- harvesting (collecting from nature)

Traditional Energy Sources...

Peat...

- renewable
- decaying plant matter in bogs
- heating
 - It is dried first
 - mostly in Ireland, England, N. Europe
 - also an ancient form of fuel!
- harvesting (collecting from nature)

Peat – an early step in coal formation



Peat's got its own journal →

Traditional Energy Sources...

Coal...

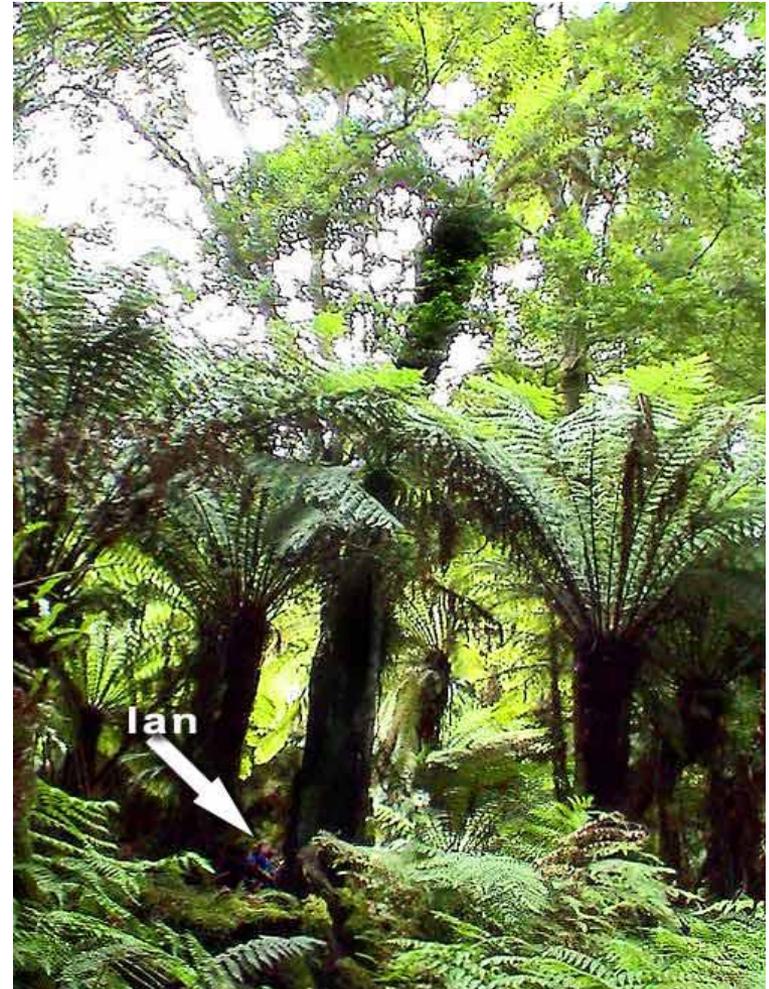
- nonrenewable
- fossilized swampy plants
- electricity production
 - burned to heat water to spin the turbines of a generator
 - USA has more coal than the world has oil!
 - burning bituminous coal causes air pollution
- mining (surface pit or underground)

The Coal Formation Process

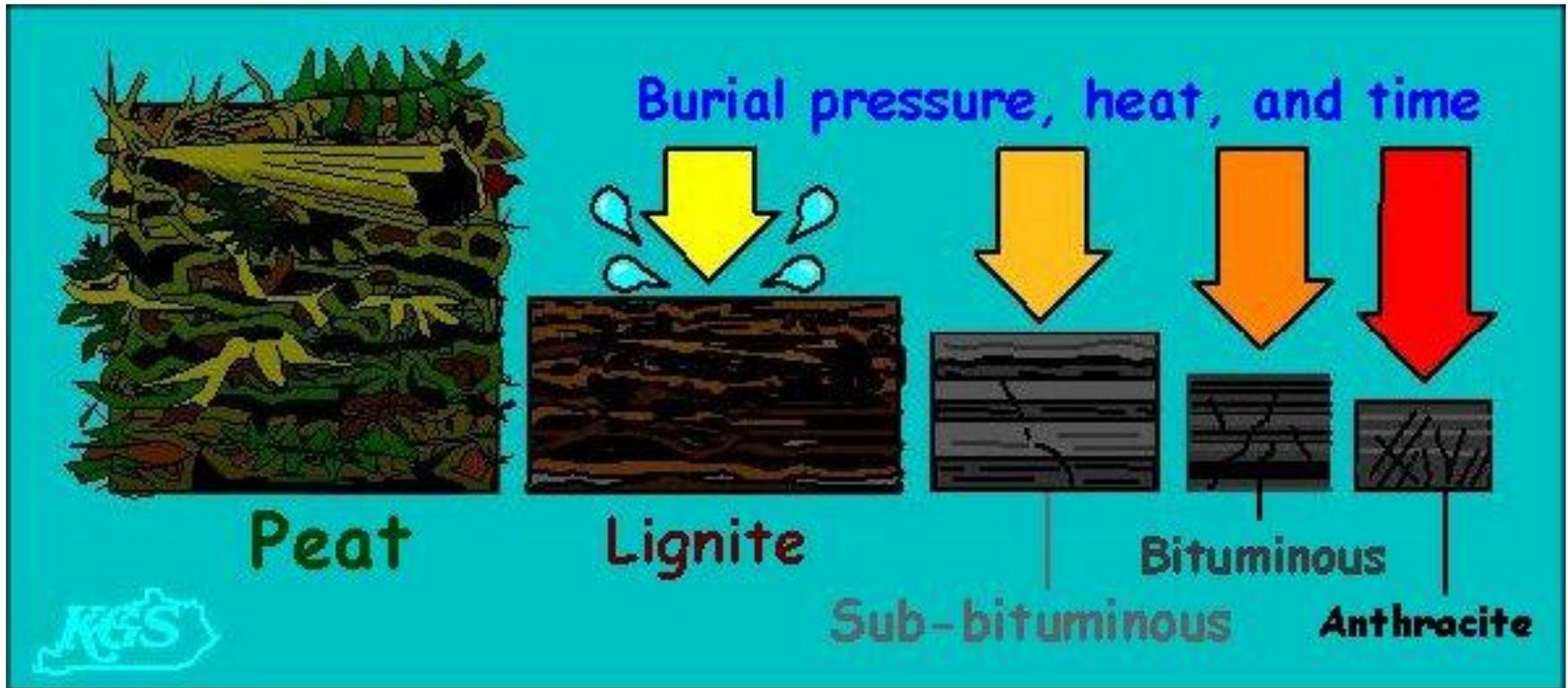
1. Today's **coal formed** from prehistoric vegetation that accumulated thousands of years ago when much of the Earth's surface was covered in swamps.

As the plants and trees in these **swampy areas** began to die, their remains sank into the swamp land, which eventually formed a dense material called peat.

Modern giant tree fern



The Steps of Coal Formation...



Most of the coal burned in the USA is bituminous.

A coal seam exposed by mining



<http://rogerphilpot.homestead.com/mechanicalploughcolor.jpg>

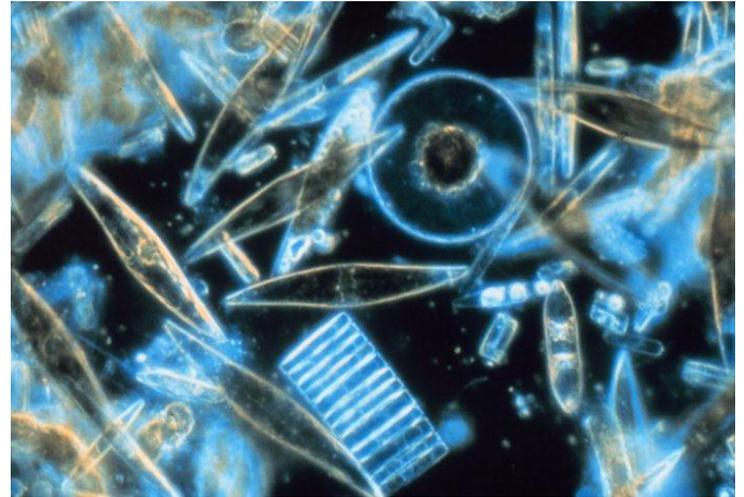
Traditional Energy Sources...

Petroleum...

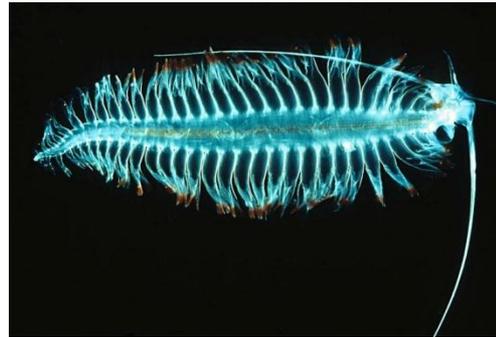
- nonrenewable
- fossilized plankton
- refined for gasoline, mostly
 - “rock oil”
 - found in porous sedimentary rocks similar to how groundwater is stored
 - a mixture of hydrocarbons (H and C)
- drilling - oil derricks (land) / oil rigs (offshore)

Petroleum forms from plankton...

These are diatoms, a type of phytoplankton



These are examples of zooplankton



<http://en.wikipedia.org/wiki/Image:Tomopteriskills.jpg>



http://en.wikipedia.org/wiki/Image:Diatoms_through_the_microscope.jpg

http://en.wikipedia.org/wiki/Image:Diatoms_through_the_microscope.jpg

Two examples of oil derricks



<http://www.freepower.co.uk/site-3.htm>



Derricks are structures that hold pumps (or drills) used to harvest oil and gas from beneath the ground.

An offshore oil rig



www.offshore-technology.com



<http://www.oil-rig-jobs.com/>

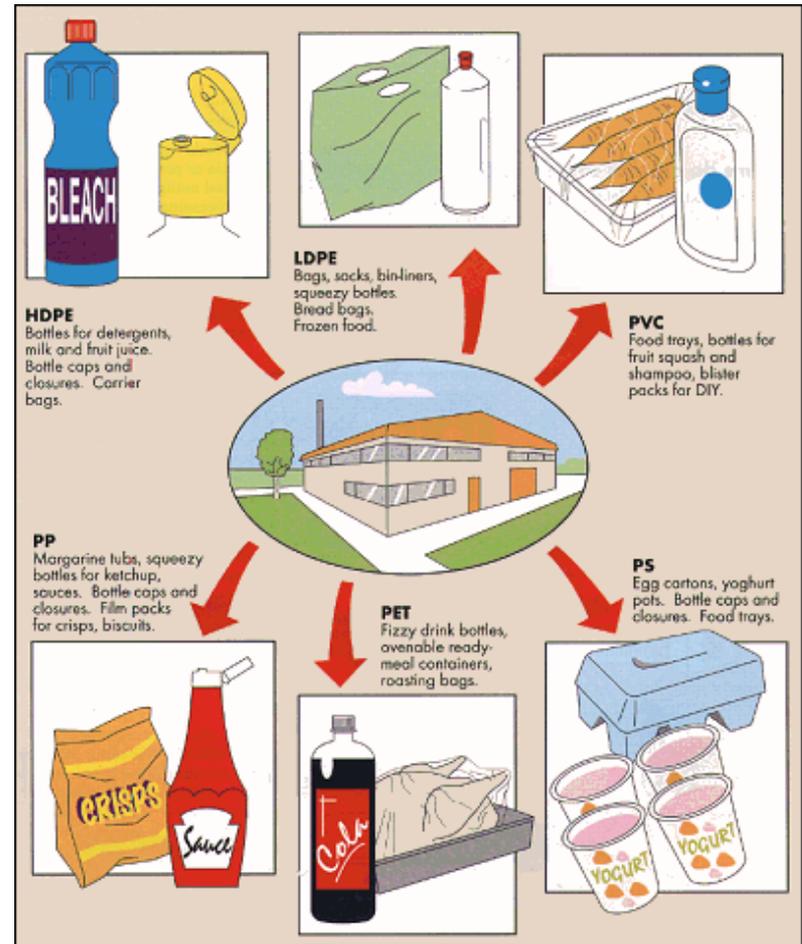
http://www.eia.doe.gov/kids/energy_fungames/energyant_trips/trip_offshore.html

The Shell oil refinery at Martinez, California. The tapering vertical elements are smokestacks to create draft for heating units. Most of the complex vertical units are fractionating towers. Others are flares.



Modern Uses of Petroleum...

- Gasoline
- Motor Oil
- Waxes
- Dyes
- Plastics
- Synthetic Fibers – for example, polyester



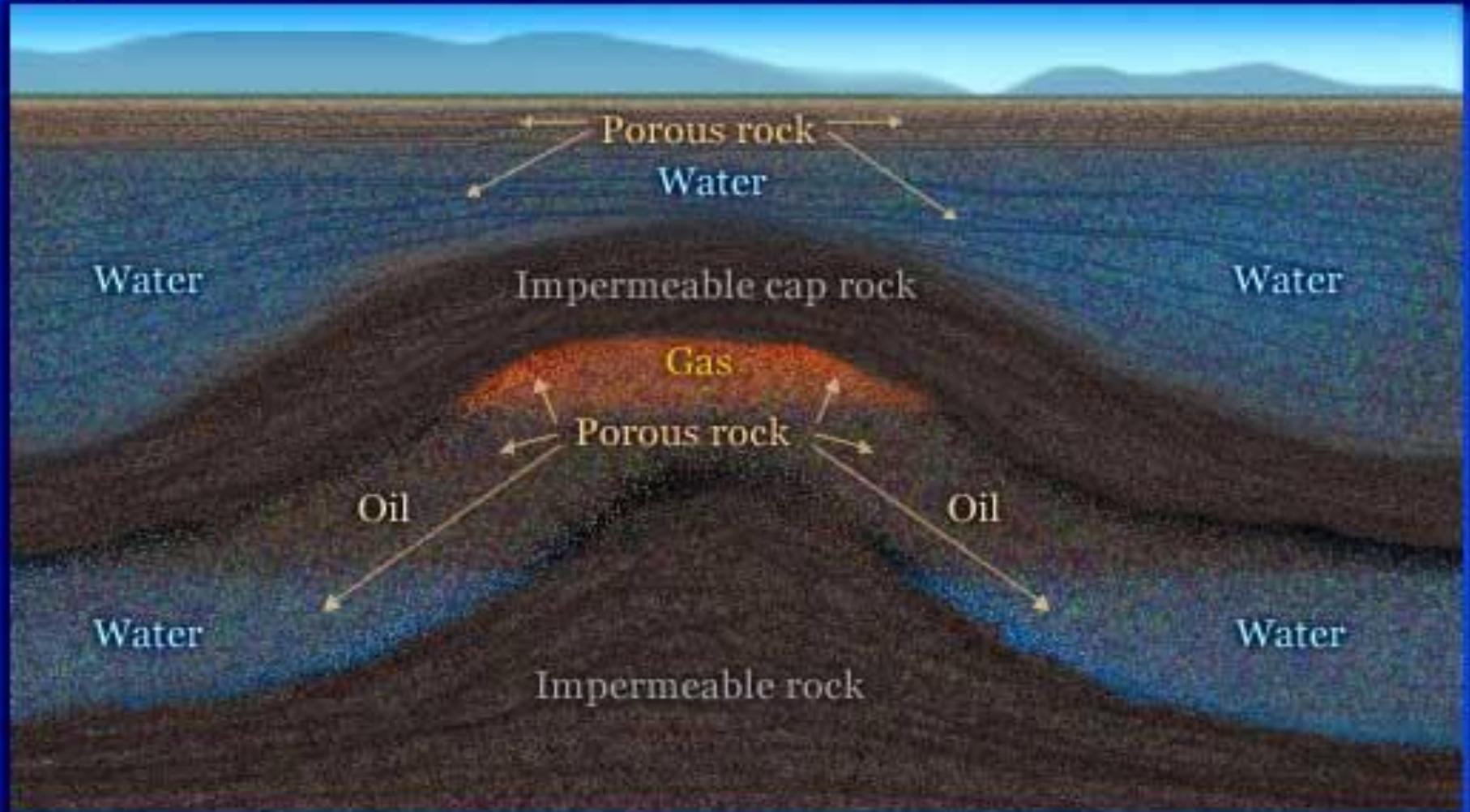
Traditional Energy Sources...

Natural Gas...

- nonrenewable
- fossilized plankton
- heating and cooking
 - found in pockets above petroleum deposits
 - a mixture of lightweight hydrocarbons
 - cleanest burning of fossil fuels
- drilling – along with petroleum
- fracking – “fracturing” rocks to release gas

Natural gas ...

Typical Oil and Gas Reservoir



Traditional Energy Sources...

Uranium...

- nonrenewable
- sandstone
- electricity production
 - nuclear FISSION produces heat to boil water to spin turbines
 - about 100 nuclear power plants in USA
 - produces no carbon emissions but ...
 - produces nuclear waste (spent uranium)
- mining

Obtaining Traditional Energy Sources...

What effects do the following ways of obtaining energy have on the environment?

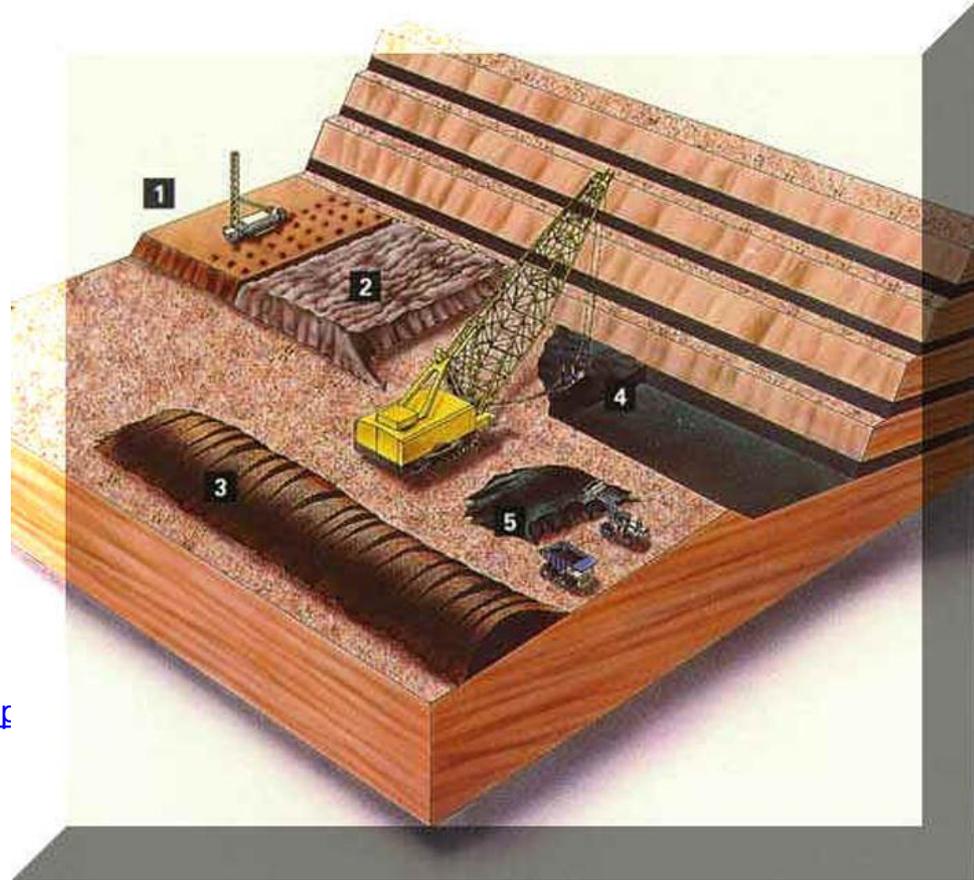
- a. **Harvesting** – has lead to deforestation and resulted in erosion and topsoil loss.
- b. **Mining** – has lead to the removal of mountaintops and pollution from mounds of waste rock.
- c. **Drilling** – has lead to oil spills and damage to the environment.

See next few slides...

Strip mining coal



http://www.geokem.com/images/scans/Indonesian_coal_mine.jp



www.globaljusticegame.mrap.info

Mountaintop Removal



What effect does this type of mining have on the environment?

Environmental Impacts of Mining for Coal

...

- a. Surface mining requires the removal of massive amounts of top soil, leading to **erosion, loss of habitat** and **pollution**.
- b. Underground mining causes acid mine drainage, which causes **heavy metals** to dissolve and seep into ground and surface water.



Mining for Uranium...

- Pictured is an open-pit uranium mine in Gas Hills, Wyo., March 1978.
- Photo courtesy [DOE](#)



Oil Spills...

Worker cleans a rock on the beach of Green Island, Alaska, after the Exxon

advocacy.britannica.com



[://library.thinkquest.org/CR0215471/oil_spills.htm](http://library.thinkquest.org/CR0215471/oil_spills.htm)

Should the USA drill in ANWR?



- This is the Alaska National Wildlife Refuge.
- The debate of whether to drill for petroleum in ANWR is ongoing.
- <http://www.anwr.org/>

Lesson 2

Alternative Energy Sources

Think About It...

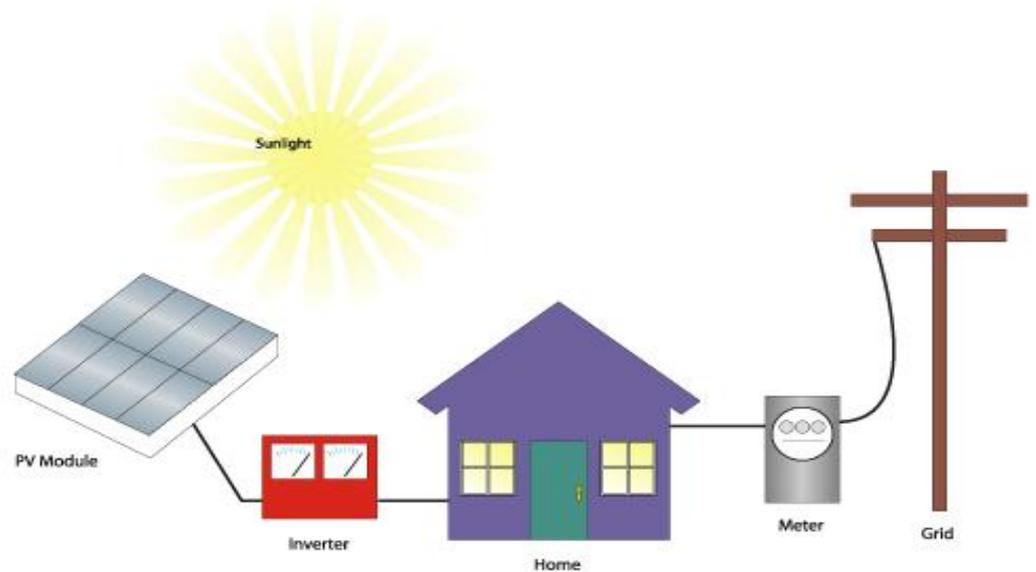
Which alternative energy would
work best in Yadkin County?

Focus Question...

What are the benefits, costs, and environmental impacts of alternative sources of energy?

Solar Energy Produces Electricity in One of Two Ways ... Photovoltaic ...

- When a photovoltaic (PV) panel is exposed to light, electrons in the silicon begin to flow as electricity.
- Silicon (from sand) is the material from which a PV cell is made.



Solar Energy Produces Electricity in One of Two Ways ... Thermosolar ...

http://www.solarnavigator.net/spanish_solar_generating_station.htm

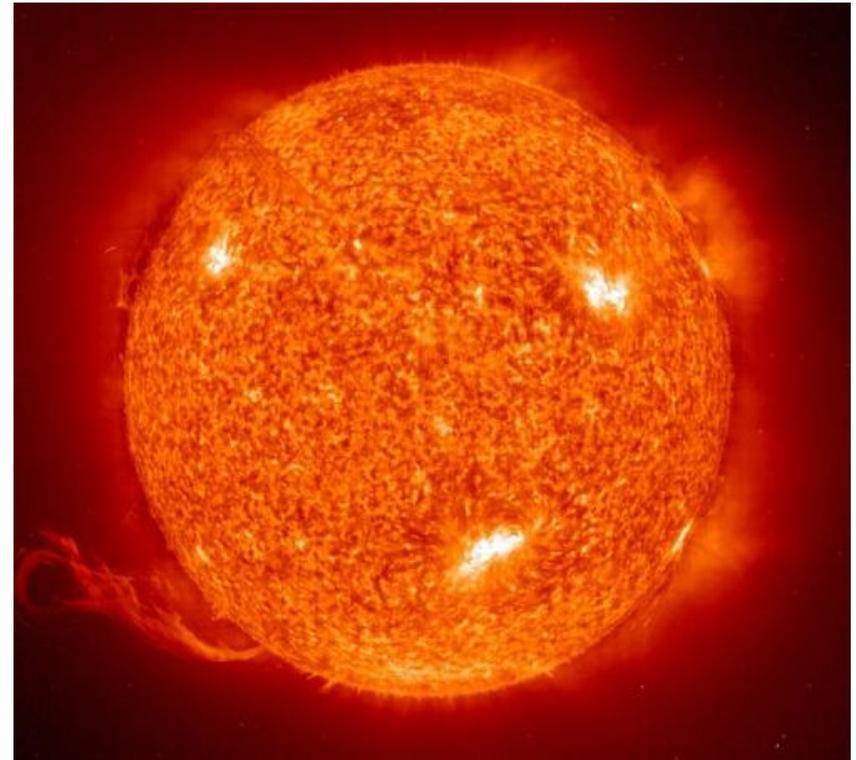


Thermosolar power stations provide another method for producing electricity. Here is a thermosolar power station in Spain

Solar Energy

Solar energy uses energy from the sun.

- **Benefits** –Solar power is clean and quiet!
- **Disadvantages** – It's expensive! (The main expense is **collecting, storing and converting the sun's rays into useful forms of energy.**)
- **Environmental Impacts** - are negligible.



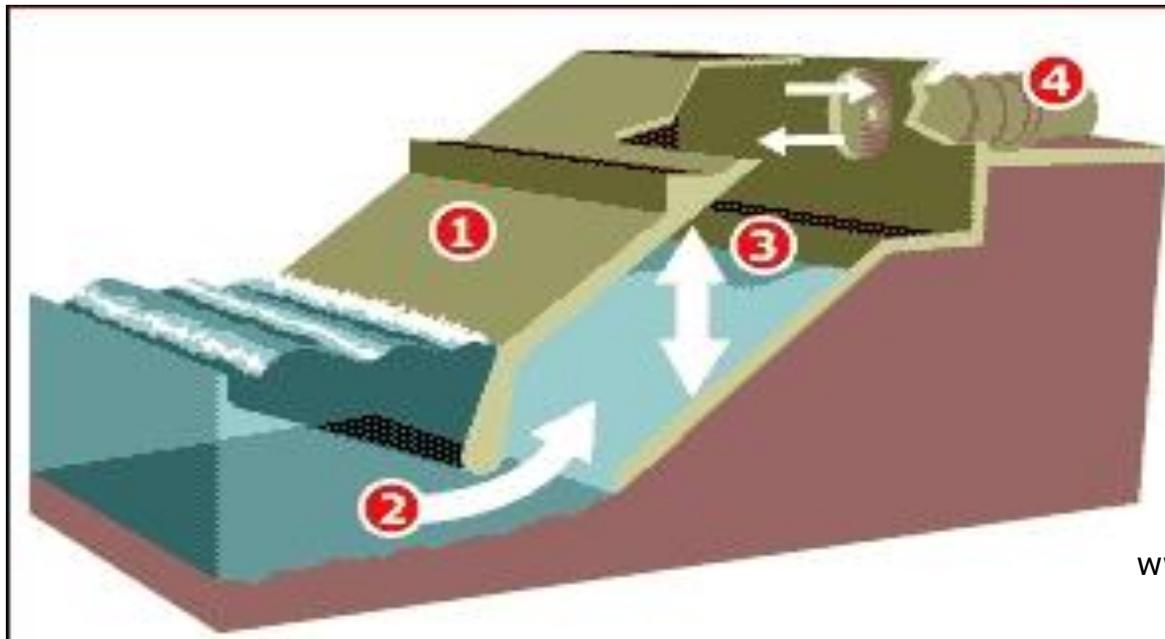
Wave Power

Wave power – turbines spin with the motion of rising and falling water, producing electricity.

Benefits – Waves are free!

Disadvantages – There aren't always waves!

Env't. Impact – Facility may disturb coastal habitats



The Geysers in California ...

Remember, *geo* means

Earth

- Geothermal energy produces electricity when “Earth’s heat” turns water to steam to spin turbines
- It can also heat water and homes.



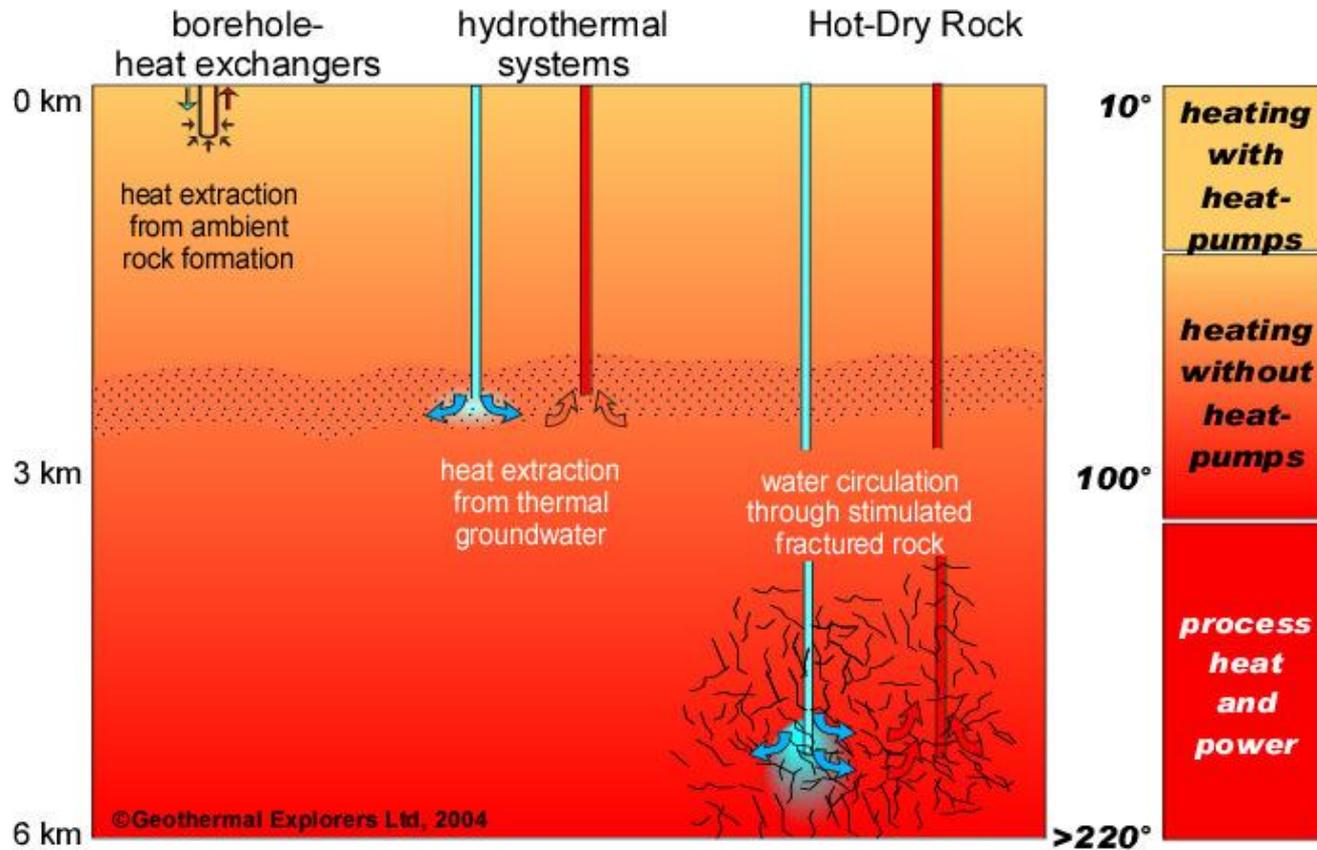
Geothermal

Iceland is on the North Atlantic Volcanic Rift Valley, so it is a prime location for using geothermal energy. Over 90% of homes in Iceland are heated with this energy source.

Here is the Bjarnarflag Geothermal Station in northeast Iceland.



Geothermal Energy – Use in NC



Geothermal Energy

- Benefits – The energy source is free!
- Disadvantages
 - Geographic restrictions – not every place has geothermal energy sources near the surface
 - The cost of drilling down into hot rocks (as deep as 6 miles!) is very high
- Environmental impacts - habitat disturbance and the disposal of large quantities of noxious gases and very salty water.

Wind Power – Old to New!



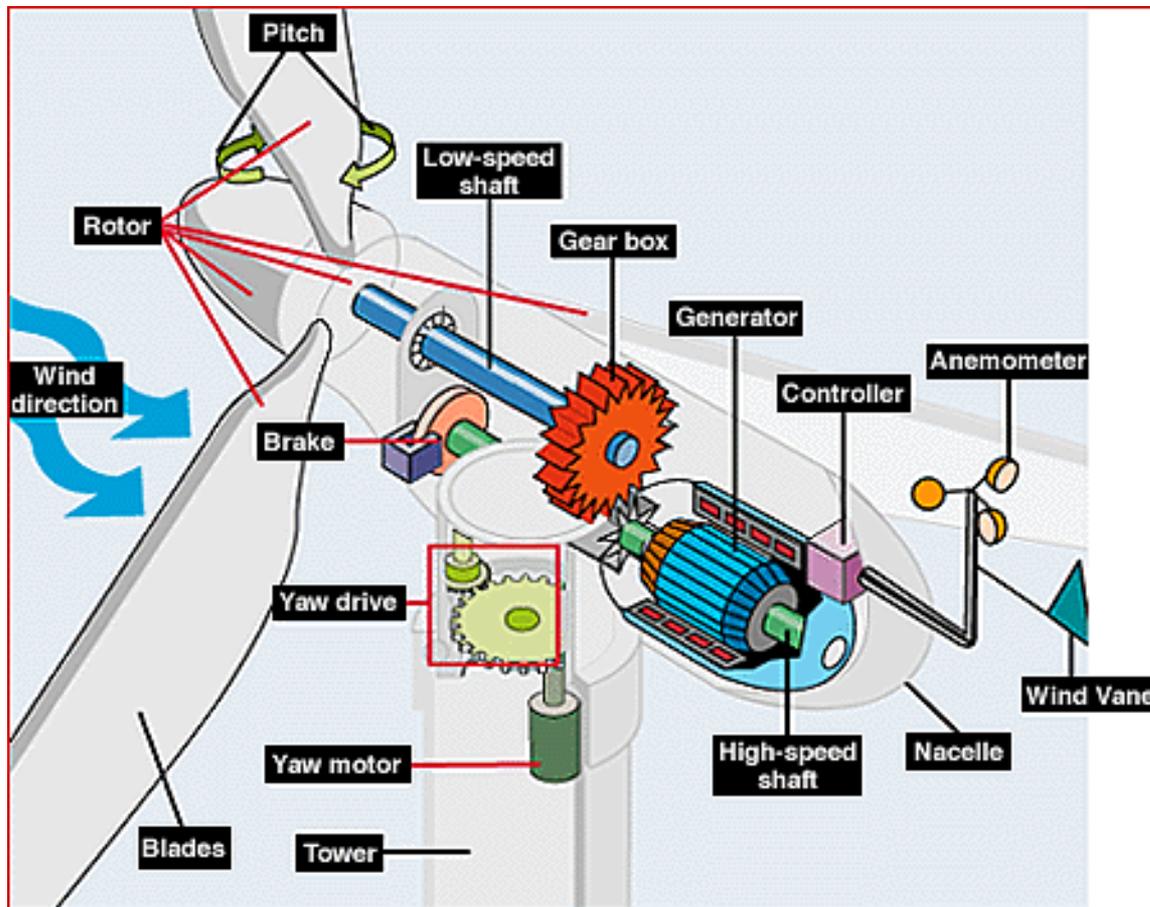
Wind power has been used to pump water for centuries



A modern wind turbine produces electricity.

Wind Power

Wind mills generate electricity when the wind spins the giant turbines.



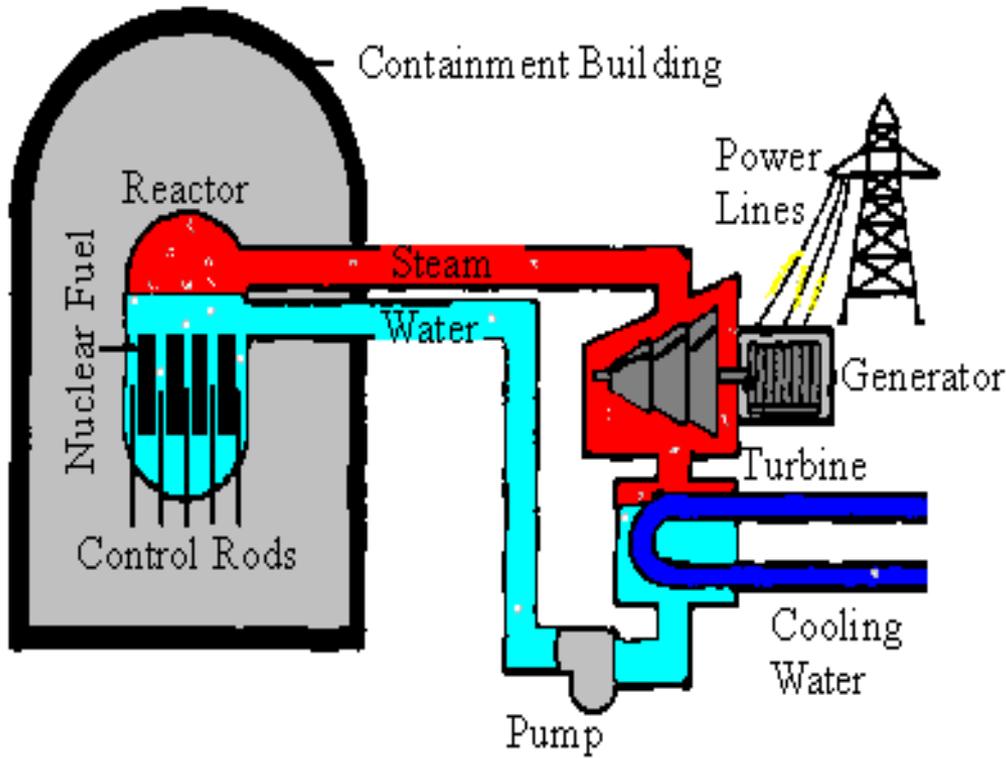
Wind Power

- ▶ **Benefits** – Wind is free and clean!
- ▶ **Disadvantages** – The wind doesn't always blow!
- ▶ **Environmental Impacts** - wind farms can be noisy, unsightly, and can kill migrating birds.



Nuclear Energy Produces Electricity...

Nuclear FISSION produces heat to boil water to spin turbines



www.comedition.com

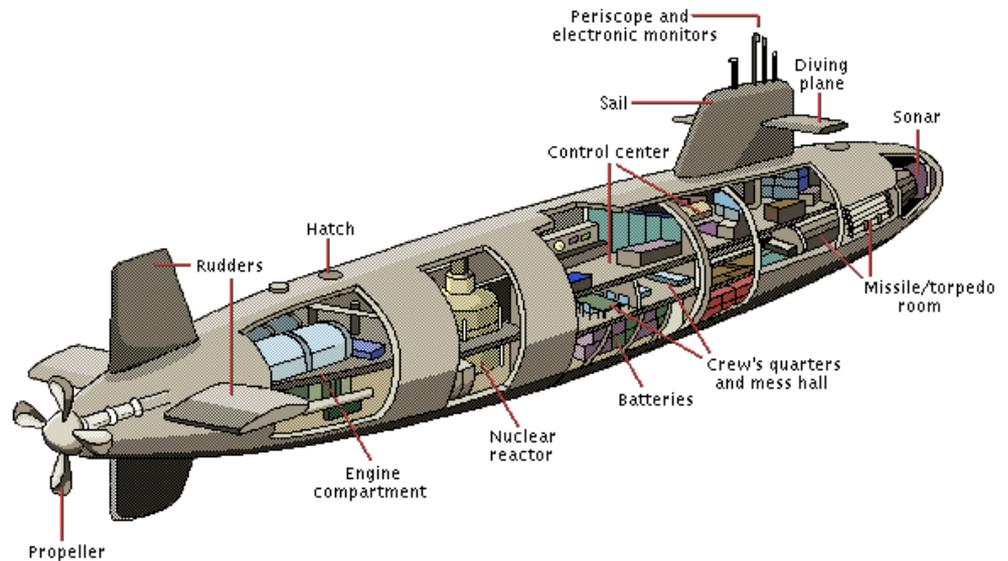


www.pollutionissues.com

Nuclear Energy

Fission reactions are used to supply significant amounts of energy for...

- Electricity
- Heating
- Military use- for nuclear submarines!



Nuclear Energy

- **Benefits...**
 - It produces huge amounts of energy from small amounts of nuclear fuel (uranium and plutonium).
 - Earth contains enough nuclear fuel to meet all present and future needs.



Nuclear Energy

Disadvantages...

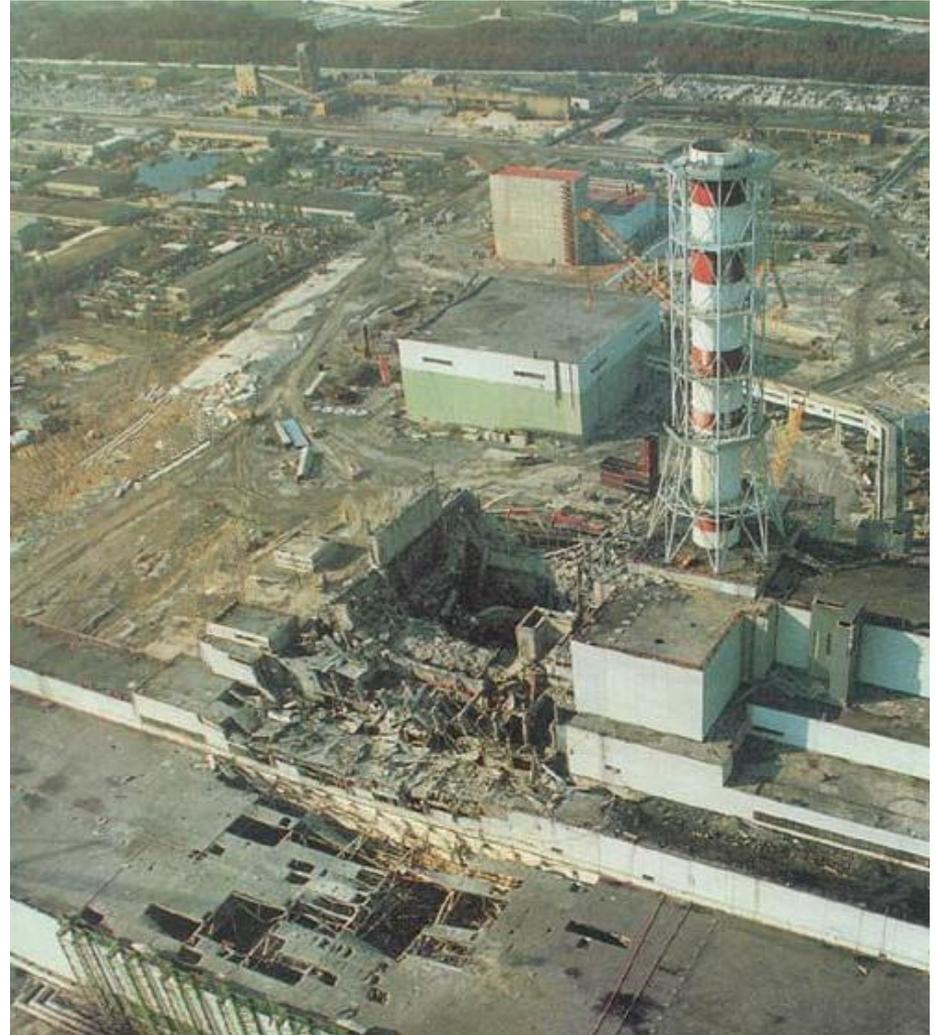
- Peoples' fear of exposure to radiation and that nuclear weapons could be developed using this technology
- High cost

Environmental Impacts...

The threat of a meltdown (nuclear explosion)

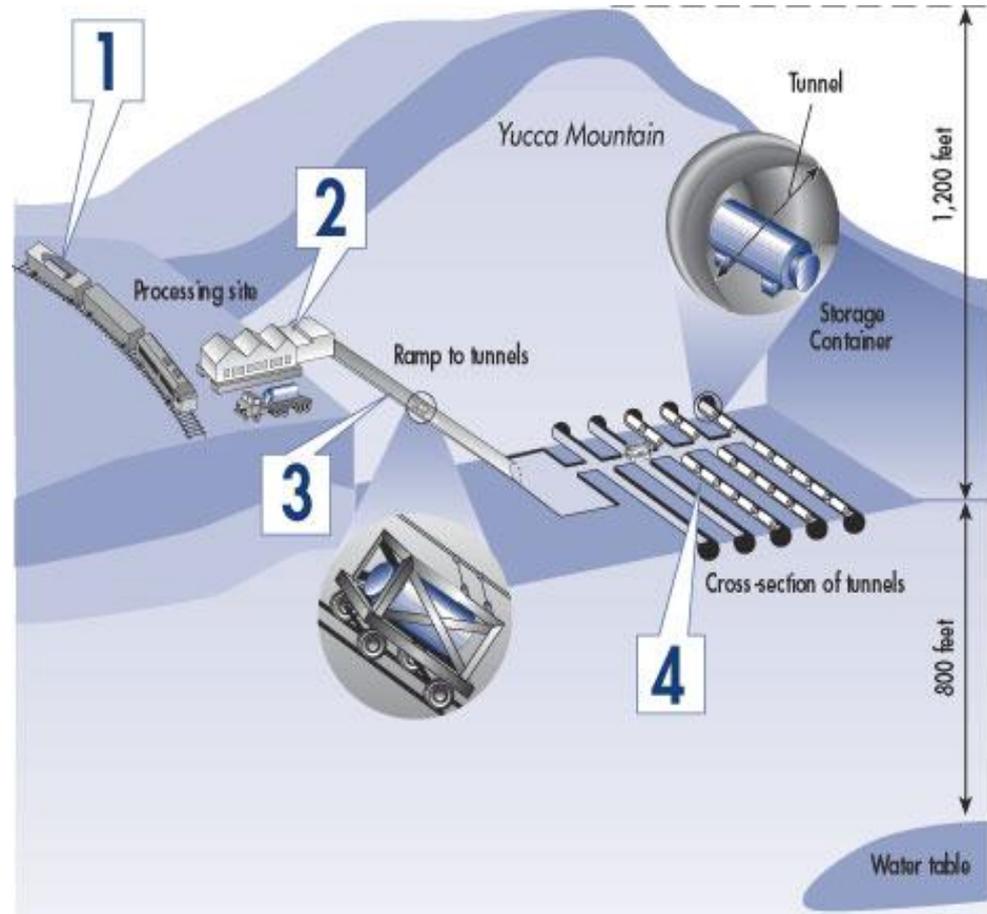
Spent fuel can remain radioactive for thousands of years!

http://todayspictures.slate.com/inmotion/essay_chernobyl/



Nuclear Energy

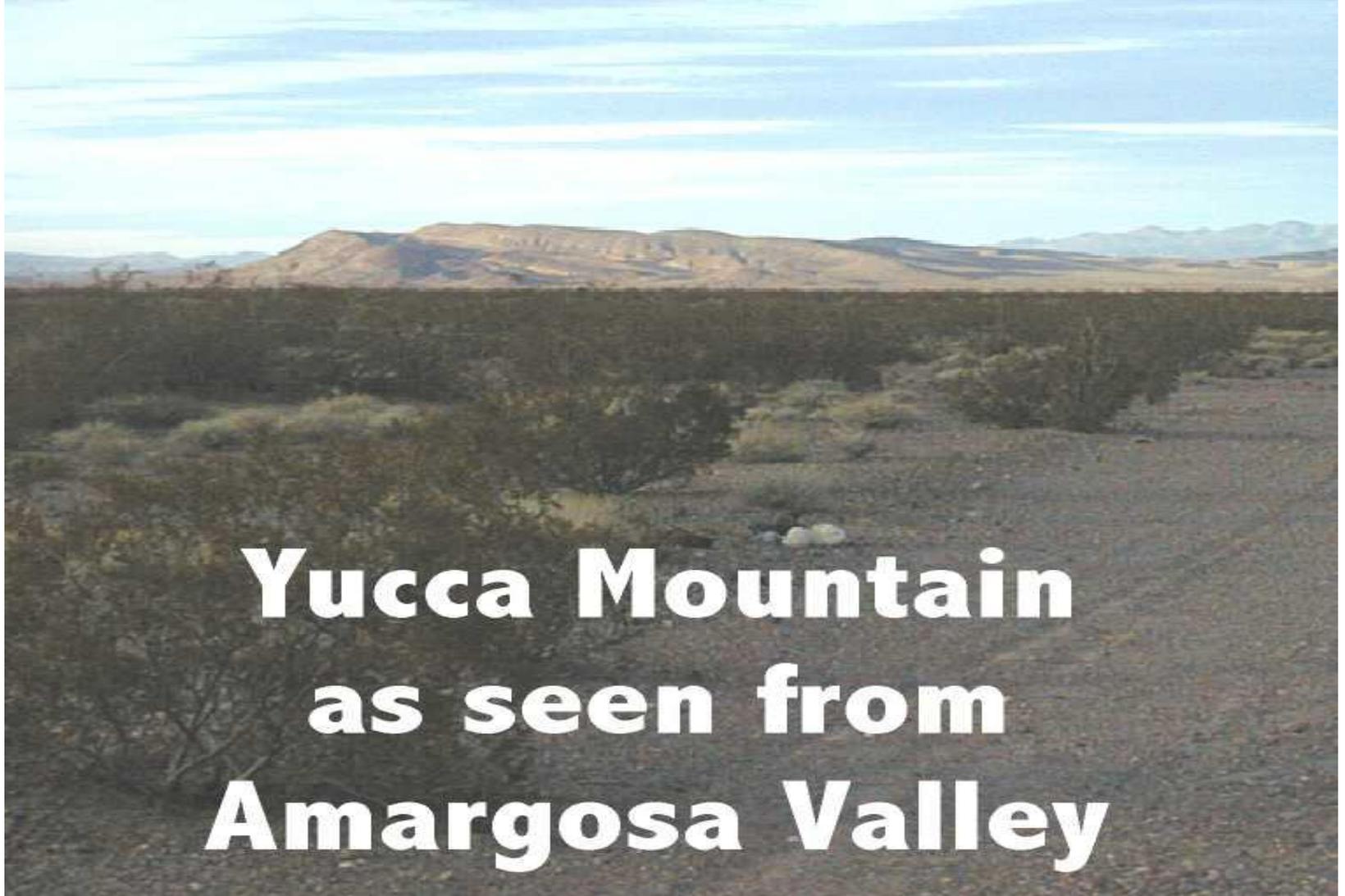
- Disposing of this radioactive spent fuel is a major problem.
- One proposed disposal site is Yucca Mountain in Nevada.



www.nrc.gov

<http://www.ocrwm.doe.gov/repository/index.shtml>

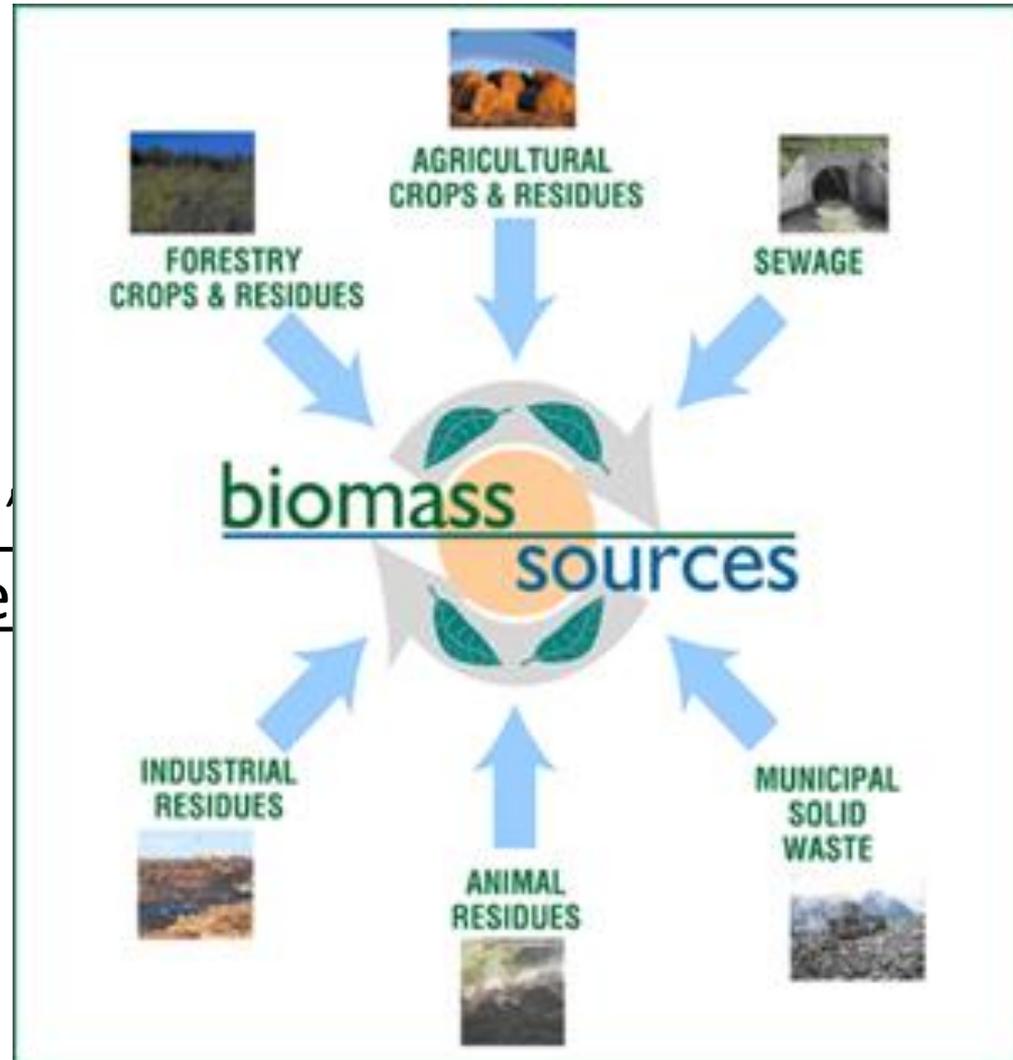
Nuclear Energy



**Yucca Mountain
as seen from
Amargosa Valley**

Biomass

- Biomass includes municipal wastes, crop residues, manure, lumber and paper by-products.
- Biomass is “combusted or burned to heat water to produce electricity.”



Biomass

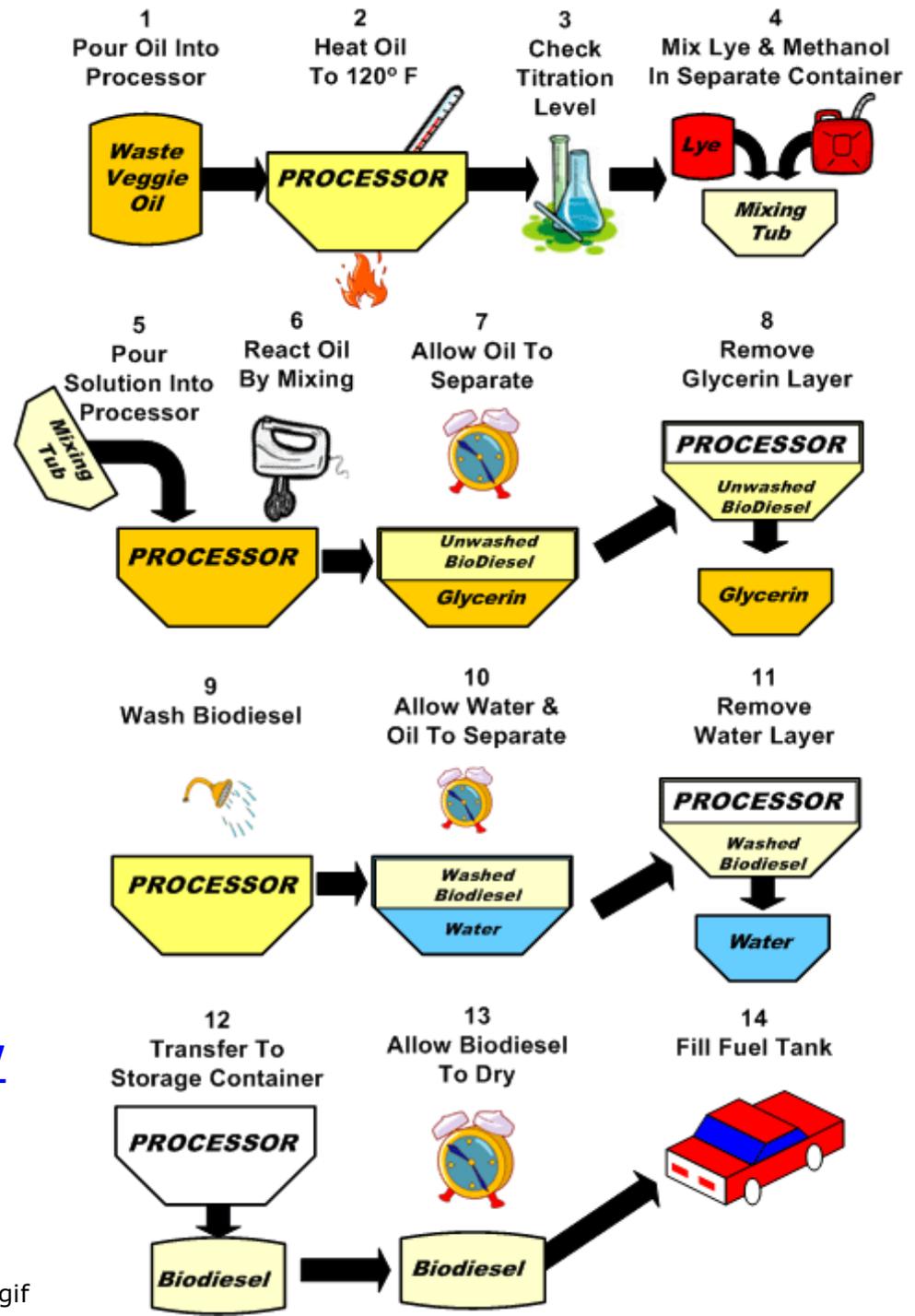
- This is switchgrass, a hardy, fast growing plant that can be used as biomass.
- It has been called “electricity on a stick!”



What is Biodiesel?



<http://www.wisegeek.com/what-is-biodiesel-fuel.htm>



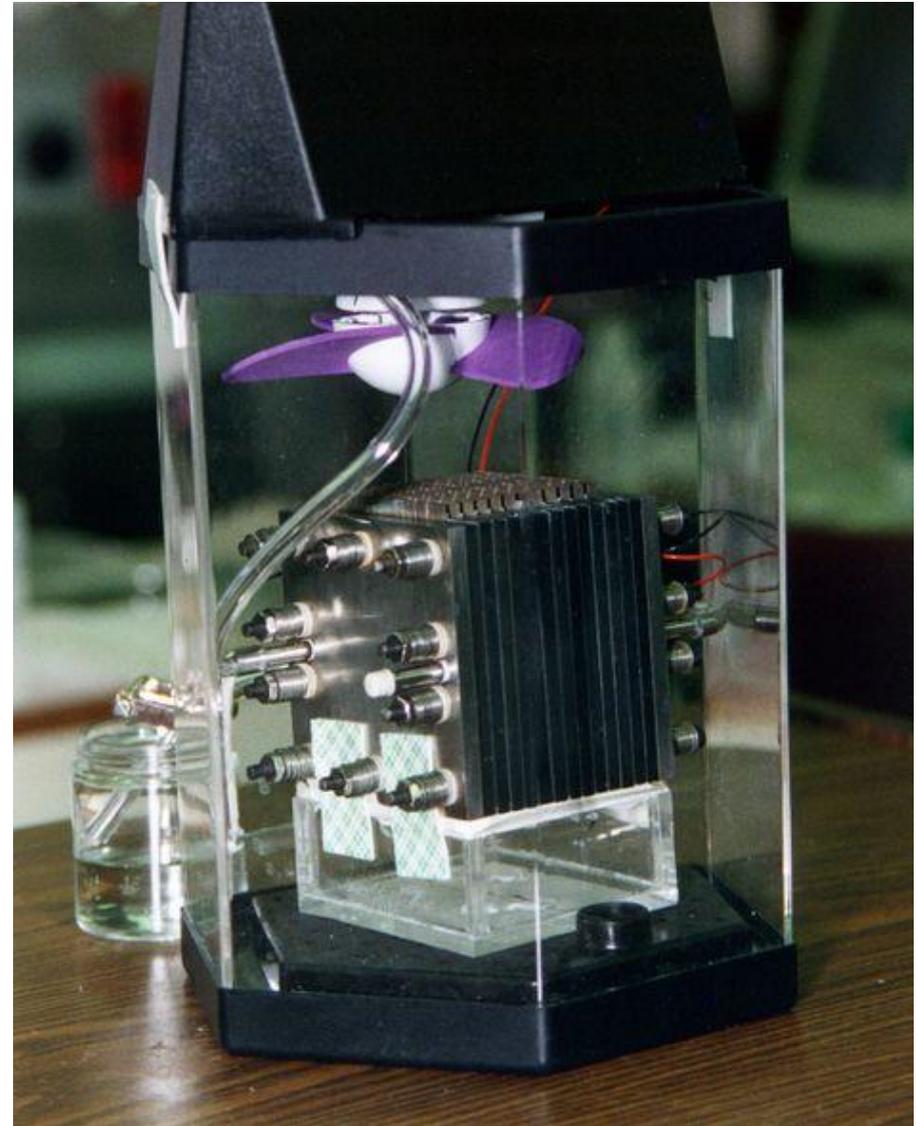
Biomass

- Benefits – renewable!
- Disadvantages –
 - “Food” is used as fuel!
- Evt. Impact –
 - The use of farm and forest residue disrupts the recycling of nutrients back into the ecosystem.
 - Generates pollution in the process of converting biomass to energy.



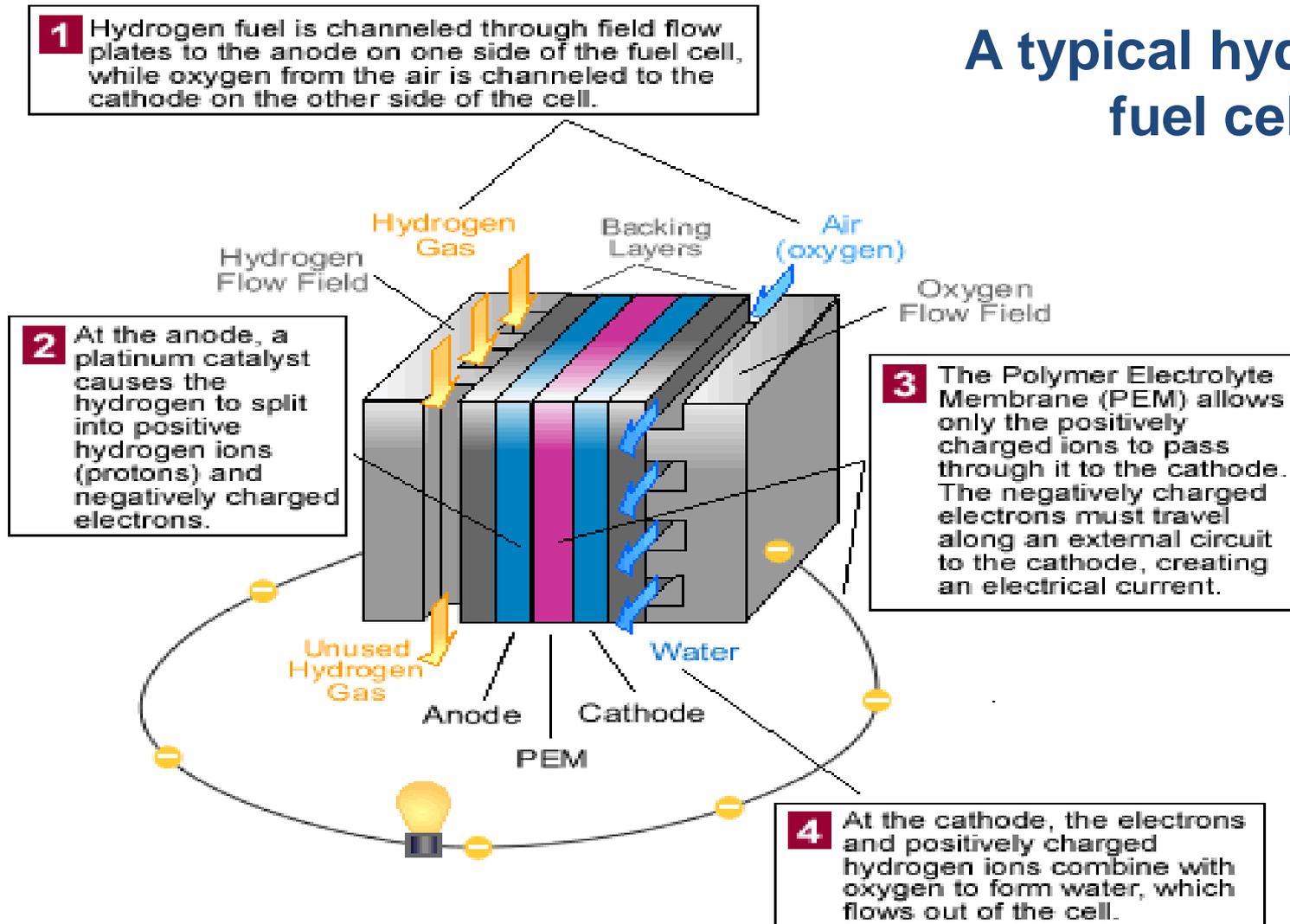
Hydrogen

- Hydrogen and oxygen chemically combine to form water and generate electricity in a fuel cell.



Hydrogen

A typical hydrogen fuel cell



A Hydrogen-powered Car...

<http://automobiles.honda.com/fcx-clarity/>



The Honda Clarity

Hydrogen

- Benefits - Fuel cell reactions produce no pollution.
- Disadvantages -
 - Currently it is expensive. Large-scale production will reduce its costs
 - Driving range is limited with current fuel storage options
 - Current small distribution channels - California is making some progress
 - It is extremely flammable – Remember the Hindenburg!
- Env't. Impacts - Hydrogen must be in the proper form to be used as a fuel. Most hydrogen used in today's fuel cells comes from methane

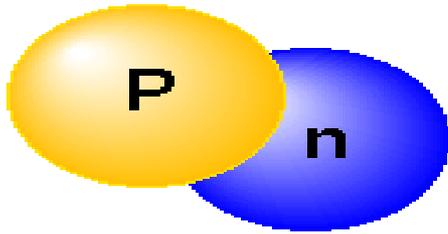
The Hindenburg...



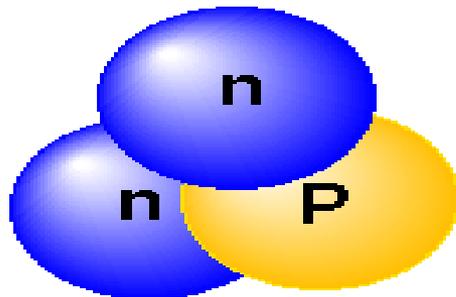
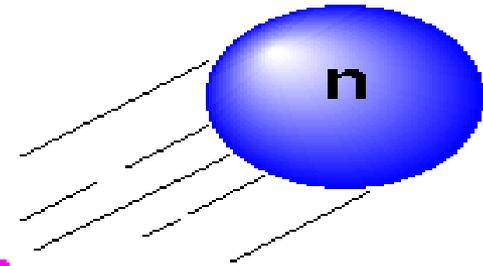
Nuclear Energy

Fusion – the combining of atomic nuclei – such as in the stars (and sun!) – generates energy which can heat water to spin turbines.

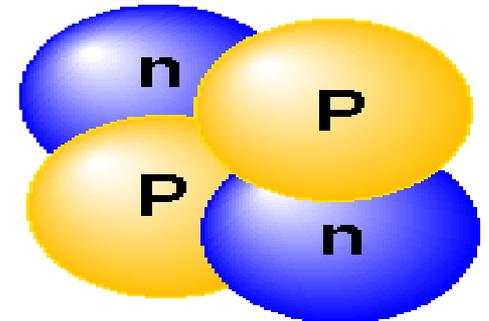
Deuterium



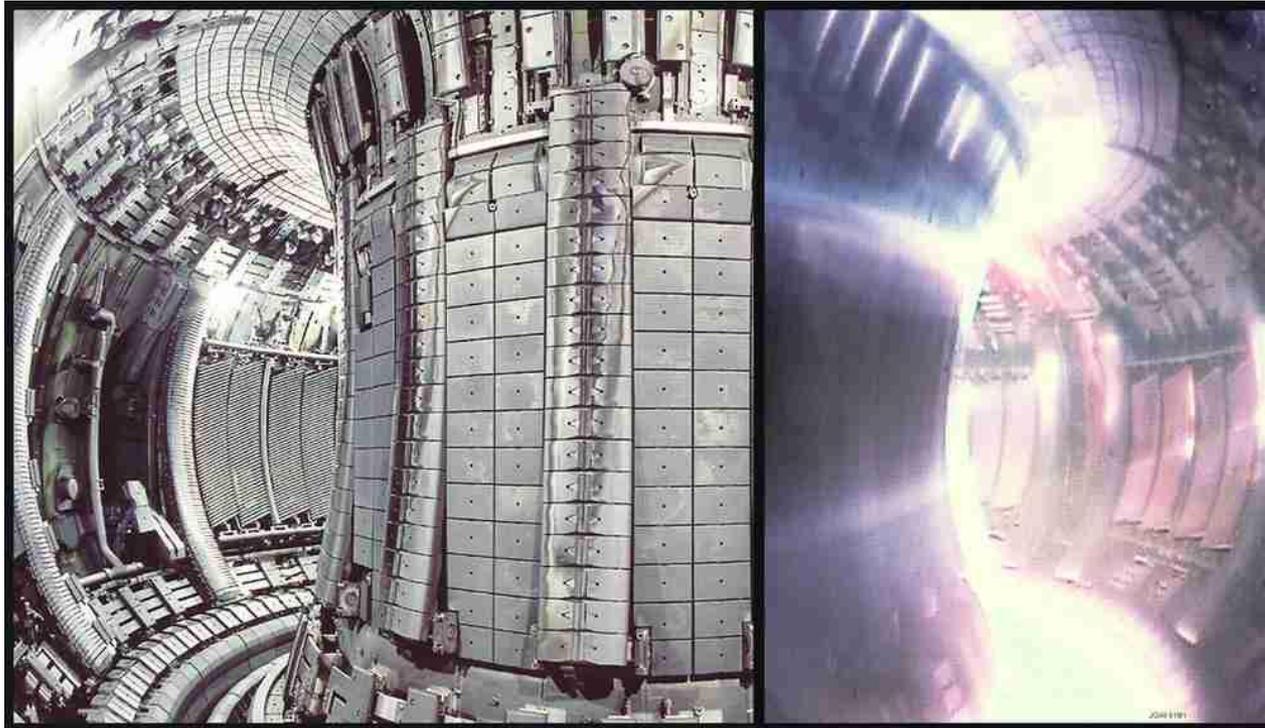
Neutron



Tritium



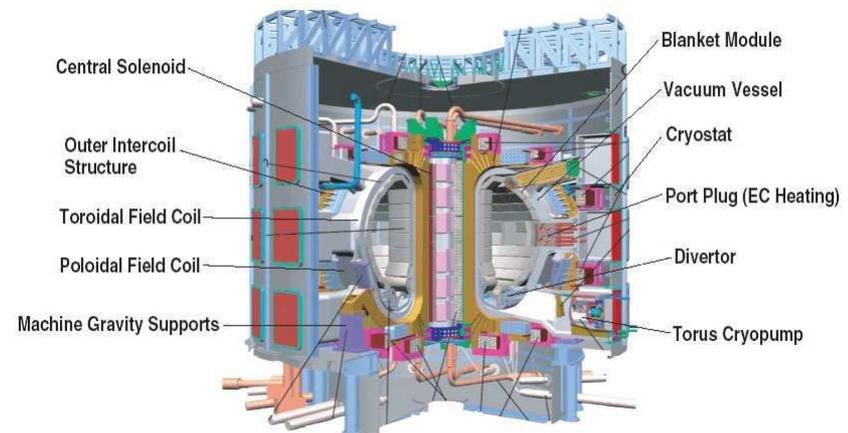
Helium



Fusion Reactor

THE ITER-FEAT MACHINE

<http://www.isfirt-erice.enea.it/Page2.htm>

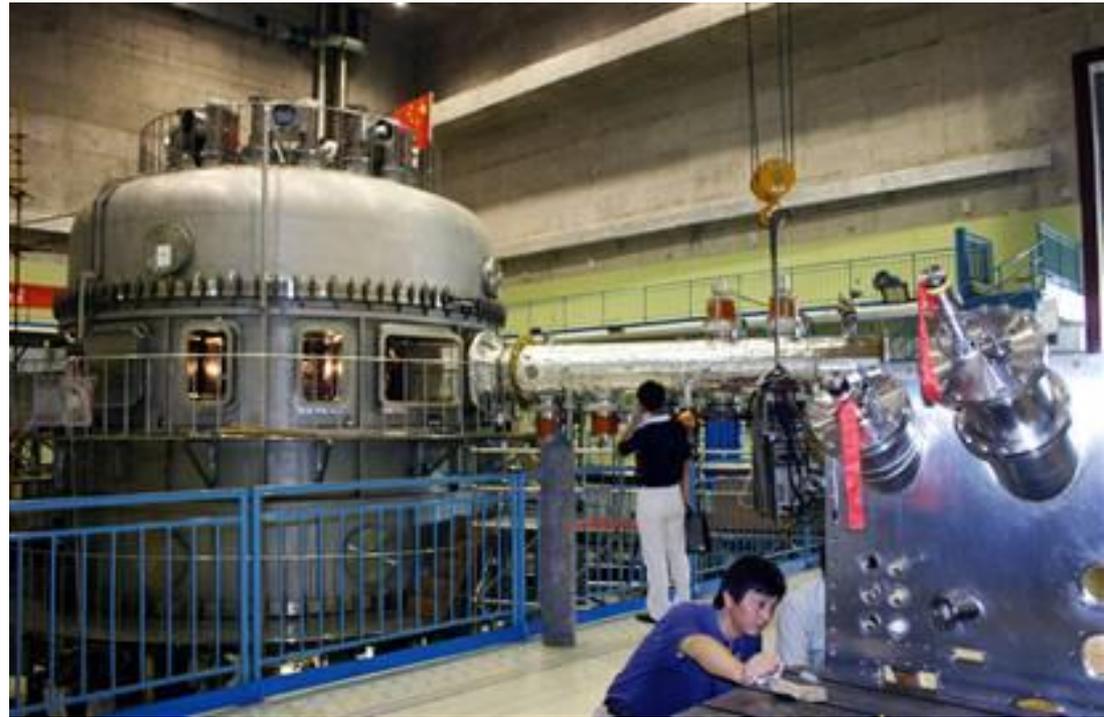


China claims fusion reactor test a success

Government hopes fusion provides clean, limitless energy source ...

- ▶ **“BEIJING - Scientists on Thursday carried out China's first successful test of an experimental fusion reactor, powered by the process that fuels the sun, a research institute spokeswoman said.**
- ▶ **China, the United States and other governments are pursuing fusion research in hopes that it could become a clean, potentially limitless energy source.**
- ▶ **Fusion produces little radioactive waste, unlike fission, which powers conventional nuclear reactors.”**

<http://www.msnbc.msn.com/id/15043462/>



updated 3:22 p.m. ET, Thurs., Sept. 28, 2006

Nuclear Energy

- Benefits - It could become a clean, potentially limitless energy source.
- Disadvantages –
 - Scientists have not yet been able to initiate a controlled, long-lasting fusion reaction suitable for producing heat and electricity.
 - Fusion reactions produce intense **radiation** that bombards all the materials in the reactor – making them intensely radioactive.
 - Fusion reactors are **very expensive** to build.
 - <http://science.howstuffworks.com/fusion-reactor.htm>
- Env't. Impacts – none, as yet!

Lesson 3

Human Population Growth

Think About It...

Why is population growth an environmental concern?

Focus Question...

What are the effects of a growing population on North Carolina?

Resources and Population Growth...

a. Survival needs...

- Food
- Water
- Energy
- Shelter – homes, clothing (protection from the “elements”)
- Clean air



nutrition.preschoolrock.com



www.nytimes.com



www.seasidehistory.co.uk

Resources and Population Growth

- b. Natural Resources** – things obtained from the environment to meet our (and other species) needs and wants
 - **Renewable**
 - **Nonrenewable**
- ▶ To sustain life on Earth, we must have...
clean air, clean water,
clean soil, and an energy source!



www.justcashews.org



www.alibaba.com

Resources and Population Growth

- c. People have the greatest impact on Earth's natural resources because...
 - ...we have an unequalled capacity to modify our environment.
- d. As a population increases...
 - ... its demand for natural resources also increases!
- e. Population growth is...
 - ... an increase in the size of a population over time.
- f. Exponential growth is...
 - ...a pattern of growth in which a population grows faster as it increases in size.
 - ... An exponential growth curve makes a 'J' shape.

Limits to Population Growth

- a. Most populations can't grow forever because...
...Earth's natural resources are limited in supply.
- b. A limiting factor is...
... a factor that will cause a population to stop increasing.
- c. A S-shaped curve is caused by...
... a population reaching an equilibrium with the resources available.
- d. Carrying capacity is...
...the number of organisms that any given environment can support.

Limiting Factors...

i. **Density-independent...**

... environmental factors that affect population growth regardless of population size.

... Examples include...

... storms

... changes in temperature

... droughts

... floods

... pollution

Limiting Factors...

ii. **Density-dependent...**

... environmental factors that affect population growth as the population's size increases.

... Examples include...

... disease

... parasites

... lack of food

Effects of a Growing Population

a. As our state's population increases, these also increase...

➤ Cars

➤ Houses

➤ Roads

Effects of a Growing Population

b. Other resources strained by population growth include ...

- Land for agriculture
- Fresh water supplies
- Clean air
- Parking spaces at the mall

Effects of a Growing Population

c. A growing population produces more...

- Solid waste (garbage)

- Sewage

- Air pollution

Lesson 4

Ecological Footprints

Think About It...

What do you need to survive?

What resources do you use to
meet your survival needs?

Focus Question...

How do your personal choices impact Earth's natural resources and contribute to your ecological footprint?

Lesson 5

Reduce, Reuse, Recycle

Think About It...

What is the impact of the practice of “reduce, reuse, recycle”?

Focus Question...

How do your personal practices
of “reduce, reuse, recycle”
impact Earth’s natural
resources?

Discuss Lesson 5

Reduce, Reuse, Recycle...

(Reduce, Reuse, Recycle)

- Think in terms of how you can implement each practice in your daily life.

Aquaculture...

- <http://www.ncagr.gov/markets/aquaculture/>
- <http://www.ncseagrant.org/home/coastwatch/coastwatch-articles?task=showArticle&id=428>

