ALTERNATIVE ENERGY

Beyond Petroleum and Coal

http://geothermal.marin.org/GEOpresentation/sld121.htm

Alternative Energy Sources

- Solar
- Biomass
- Rivers, winds and tides
- Geothermal
- Other fossil fuels
- Advancing Technologies
  - Electric sportscar
  - http://www.teslamotors.com/

Solar

- Direct uses
  - Space heating
  - Water heating
- Converted to electricity

Four Solar Systems

- Passive heating
- Active heating
- Photovoltaic
- Water heating

http://www.eere.energy.gov/solar/sh_basics.html

Passive Space Heating

- Let the Sun shine in

1. Heats air inside building
2. Heat up massive structure
   - Stone, brick, concrete
   - Returns heat to air when Sun isn’t shining

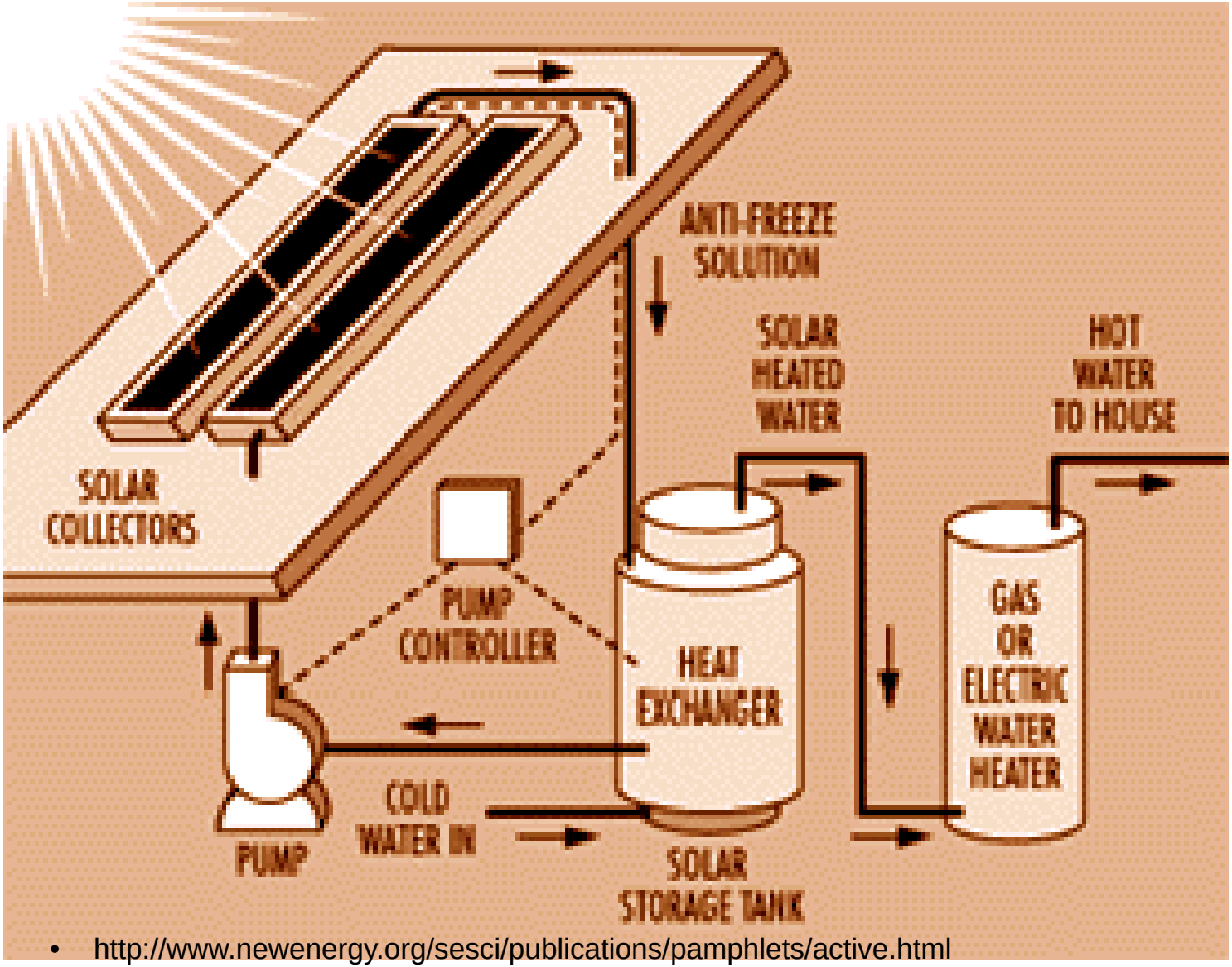
- Sun-facing windows

- http://www.earthship.com/staticpages/index.php?page=sale&osCsid=e2e983564ec7a5b9921a71236bed60c8

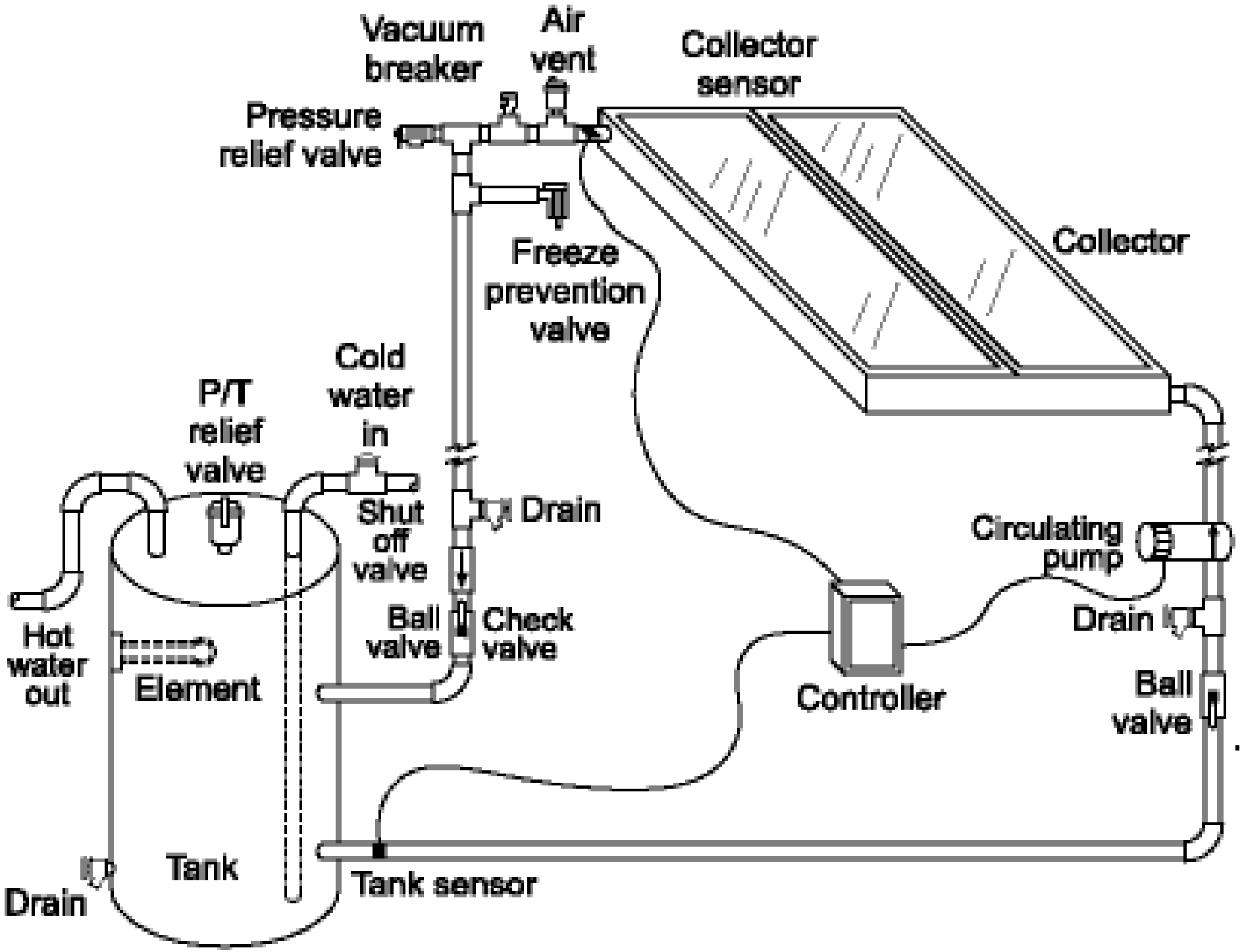
- Building for passive Sun heating
- Photovoltaic and Water heating also incorporated
- Note operable skylight for cooling

- http://www.newenergy.org/sesci/publications/pamphlets/active.html

Solar Water Heating System heat-exchange

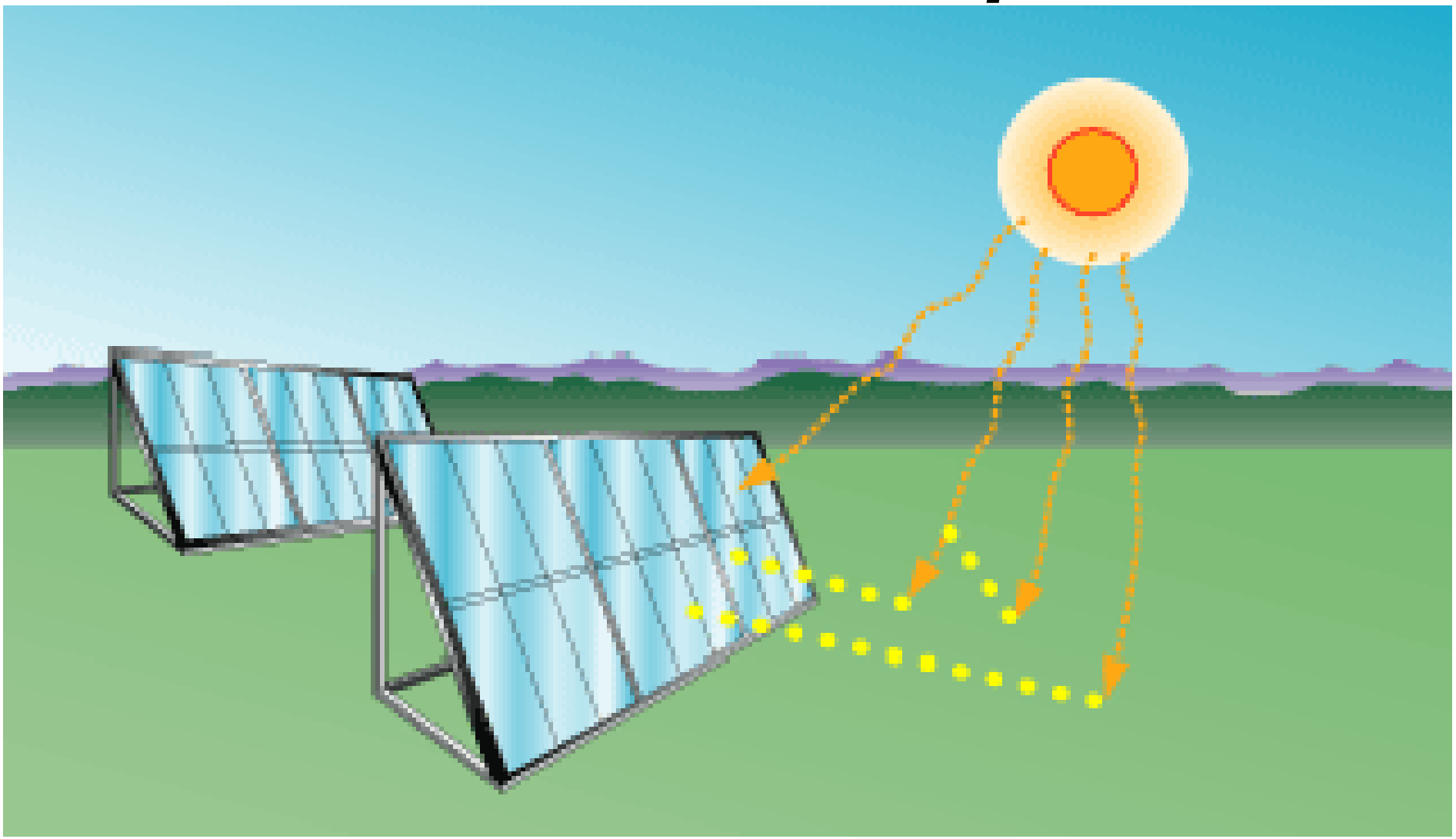


- http://www.newenergy.org/sesci/publications/pamphlets/active.html



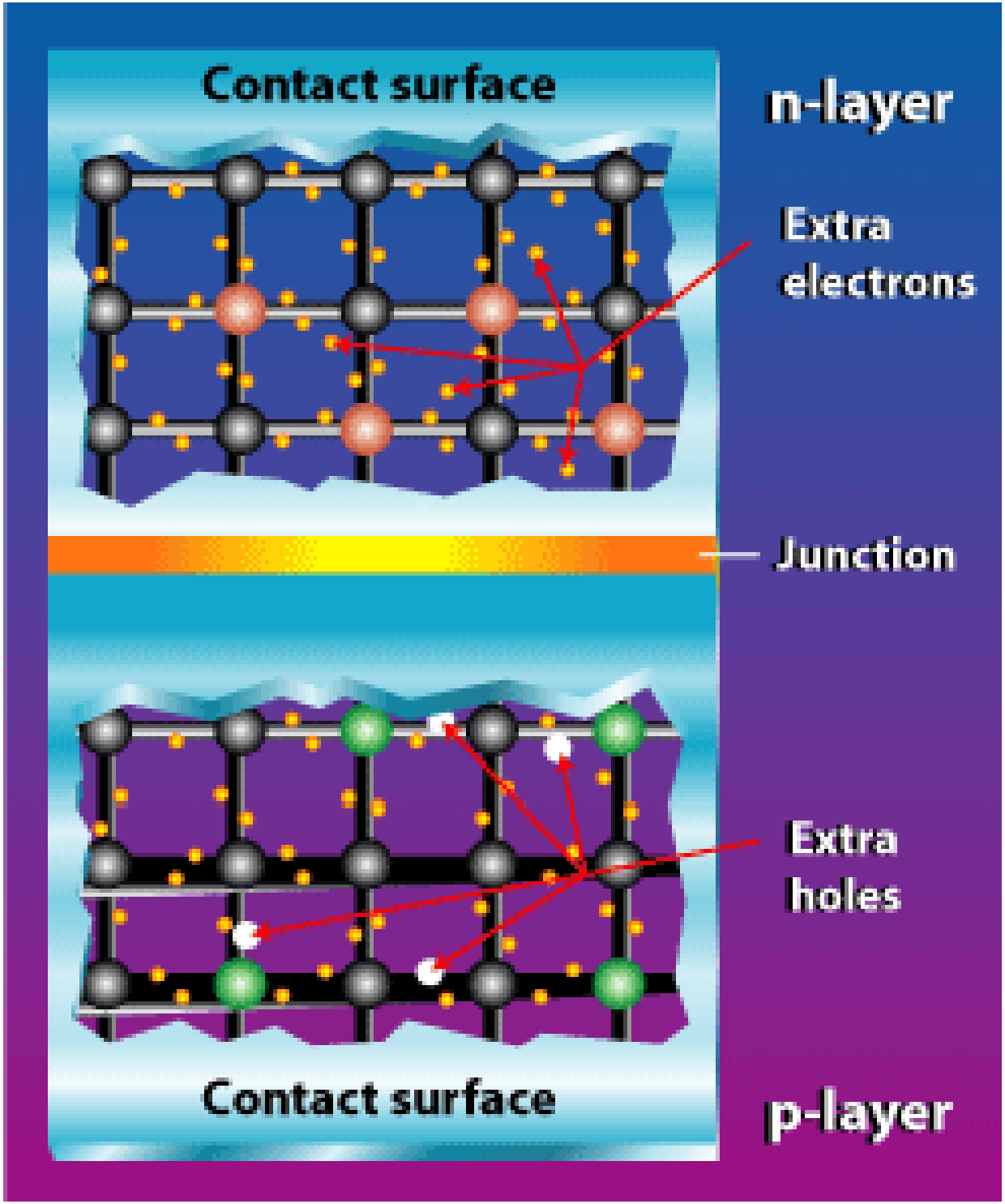
- http://www.fsec.ucf.edu/solar/apps/sdhw/en5.htm#Circulation

Sun shines directly and is reflected onto PV panels



http://www.eere.energy.gov/solar/pv_cell_light.html

How PV Panels Work



http://www.eere.energy.gov/solar/photoelectric_effect.html

Photovoltaic Electricity

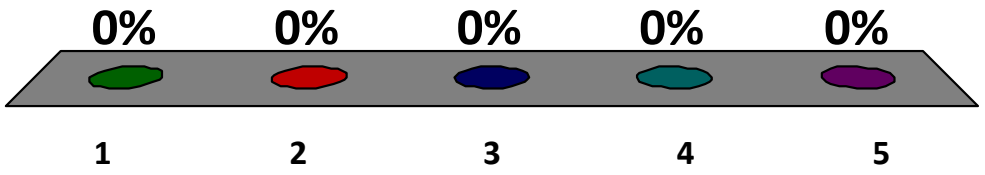
- Photons from Sun excite electrons in atoms
- Induces current flow
- Produces direct current electricity
- About 100 watts/m^2

Disadvantages to Solar

- Not much solar gain in some areas
  - Cloudy areas
  - Low sun angle
  - only works in the day, too
- Photovoltaic electricity is not very efficient
- Cost of the balance of the systems
  - Batteries
  - Panel racks and trackers
  - Inverter to get AC power

The predominant requirement for a location to install solar power would be to have

1. exposure to sunlight throughout the day
2. generators as a backup
3. grid power available as a backup
4. the temperature to be above freezing
5. none of these are important



Drawbacks of Biomass

- Lack of arable land where fuel is needed
- About 3% efficient

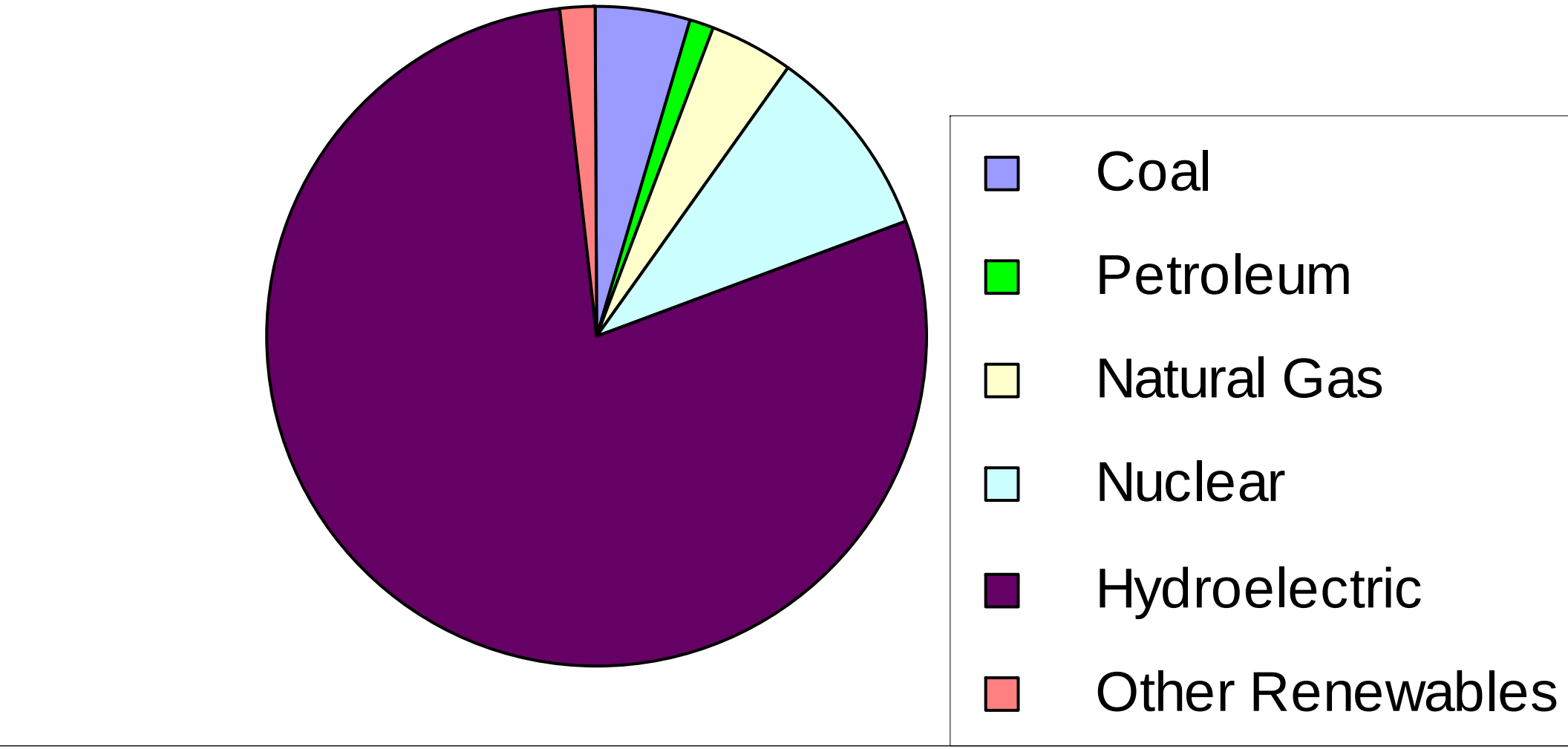
Advantages

- Utilize waste plant material
- Reduce dependence on fossil fuels
  - Corn syrup fails this test: tractor fuel for seeding and harvest
  - carbon-release of production offsets any reduction in carbon footprint of corn-syrup-derived ethanol

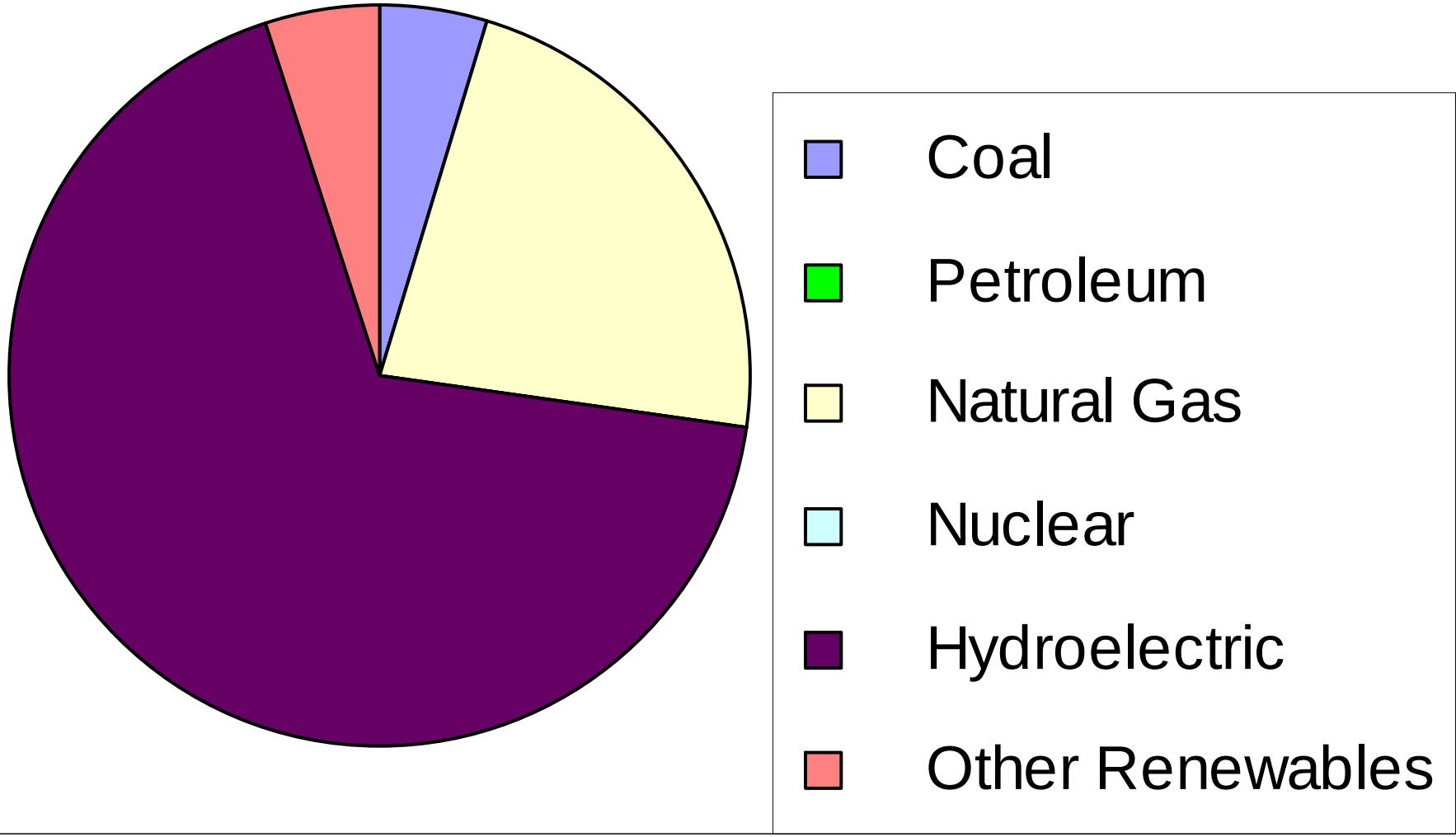
Water Power

- Hydroelectric Generation
- 9% of U.S. electricity is from hydroelectric generators (Oregon about 65%)
- Need to dam rivers where precipitation is reliable

1990 Electrical Generation

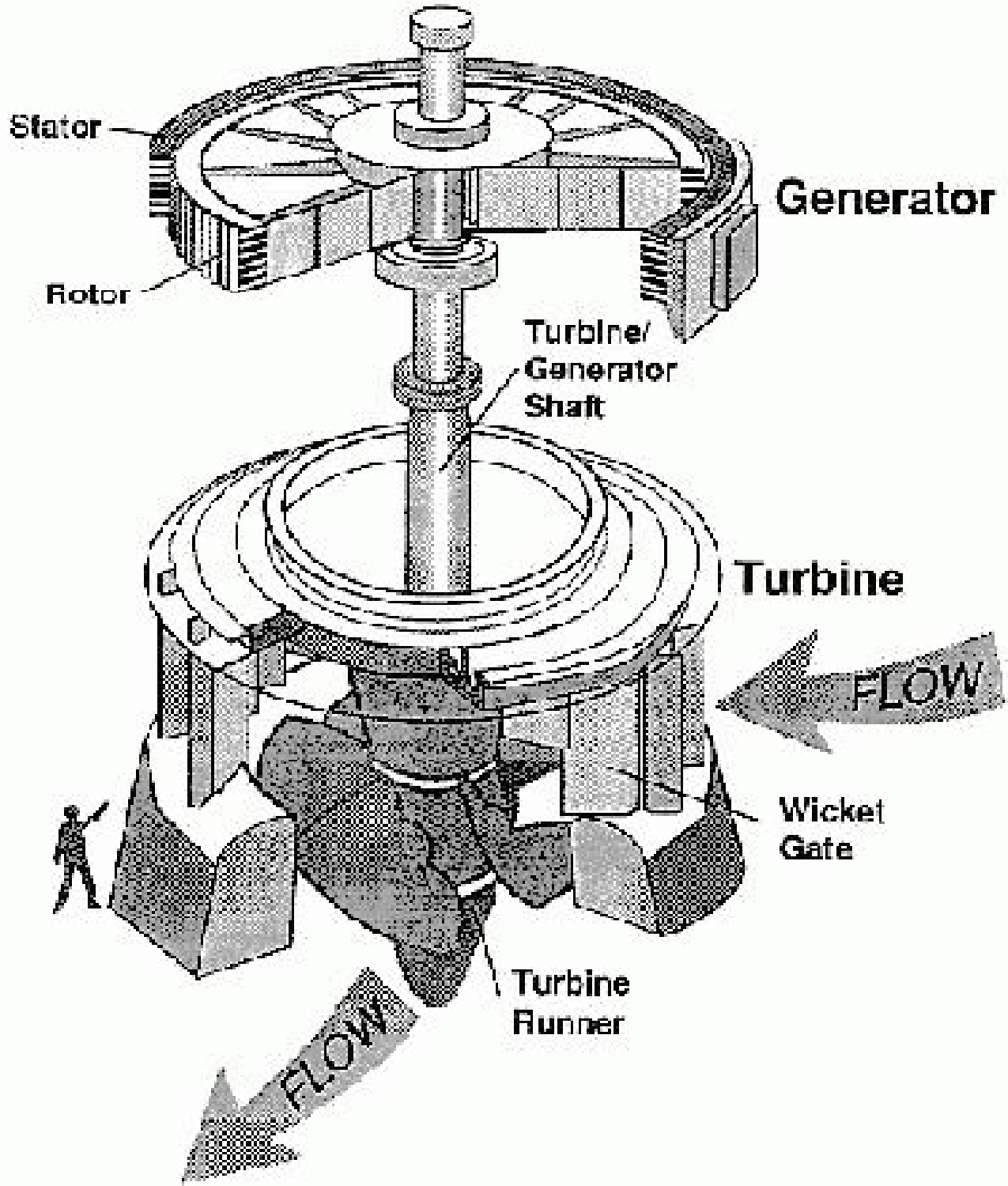


2006 Electrical Generation



Water Power

Cut away view of a water-driven electrical generator



- http://users.owt.com/chubbard/gcdam/html/hydro.html

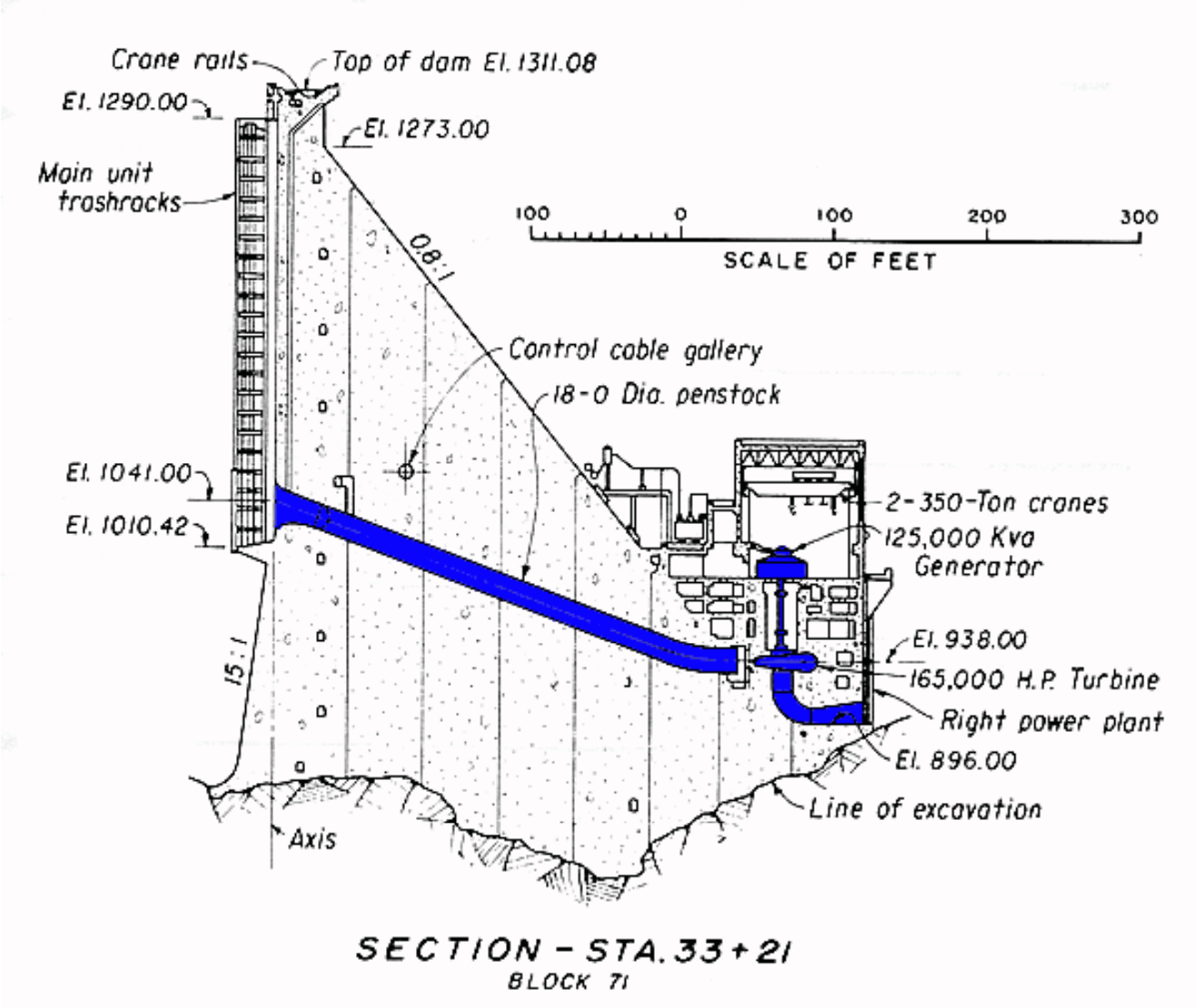
Grand Coulee Dam

•http://www.korto.com/

- North America’s largest concrete structure
- Located on the Columbia River in Central Washington

Grand Coulee Dam

- 3rd largest producer of electricity in the world
- Irrigation water and flood protection

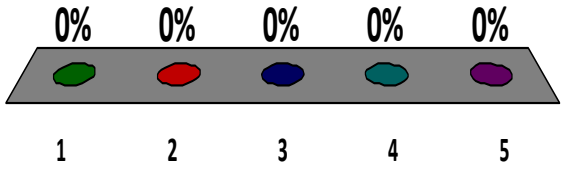


- http://users.owt.com/chubbard/gcdam/html/hydro.html

What are impacts of hydroelectric power?

1. It is a renewable resource, so there is not any impact
2. When you dam a river, the habitat next to the streams are destroyed
3. Dams withhold sediment from downstream depositional areas
4. The lakes created allow water to be warmer than a natural flowing river, and this affects fish viability
5. It is difficult for fish to migrate with dams across rivers

- You can choose more than one answer



Wind Power

- 10 Kw generator
- ~$50,000 cost
- Grid-inter-tie
  - To send power to the utility company
  - Credits toward energy you use other months

- http://www.bergey.com/

- http://www.windmilltours.com/images/blueskywindmill.jpg

Present Utilization of Wind

- Denmark 20% of its electricity
- Germany about 7% of its electric power: 25 GW
- U. S. presently generates about 2% of total power use, 35 GW
- but could easily generate 10%
- Texas, Iowa, California, Washington, and Minnesota: TX nearly as much as other 4
- Oregon capacity is ~7% of its use

Drawbacks of wind power

- Unpredictability of power generation
- Transmission: get from windy areas to use
- Wildlife impacts: birds can be killed
- Low-frequency sound affect quality of life near the generators: anecdotal evidence

Tides

- “Lunar Power”
- Tides come in and go out twice daily

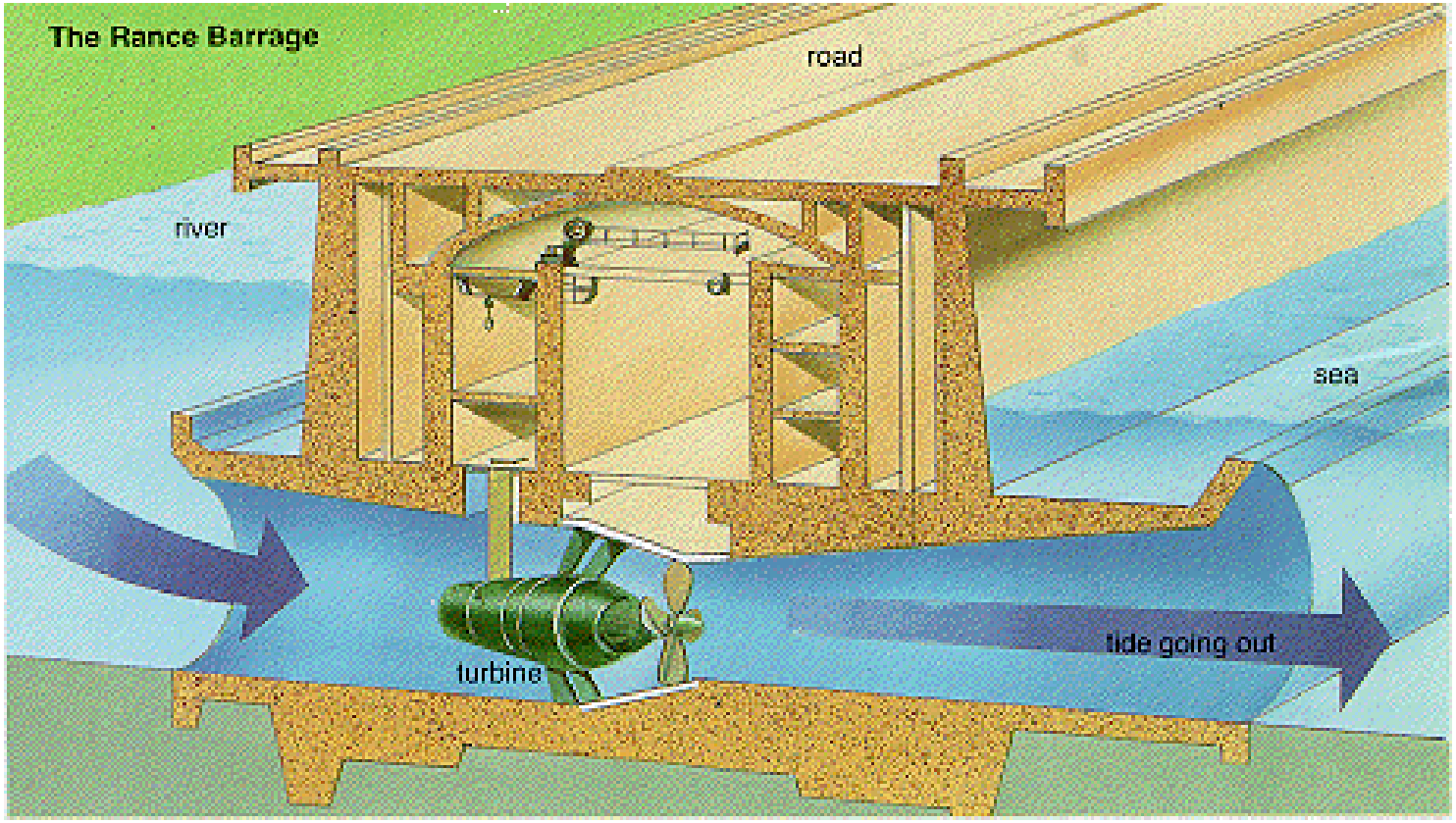
Tides

- Need area with reasonable tidal range
- Presently utilized by damming tidal estuaries where water naturally backs up
- Largest at St. Malo, France 240 MW

La Rance, France

http://www.edf.fr/html/en/decouvertes/voyage/index.html

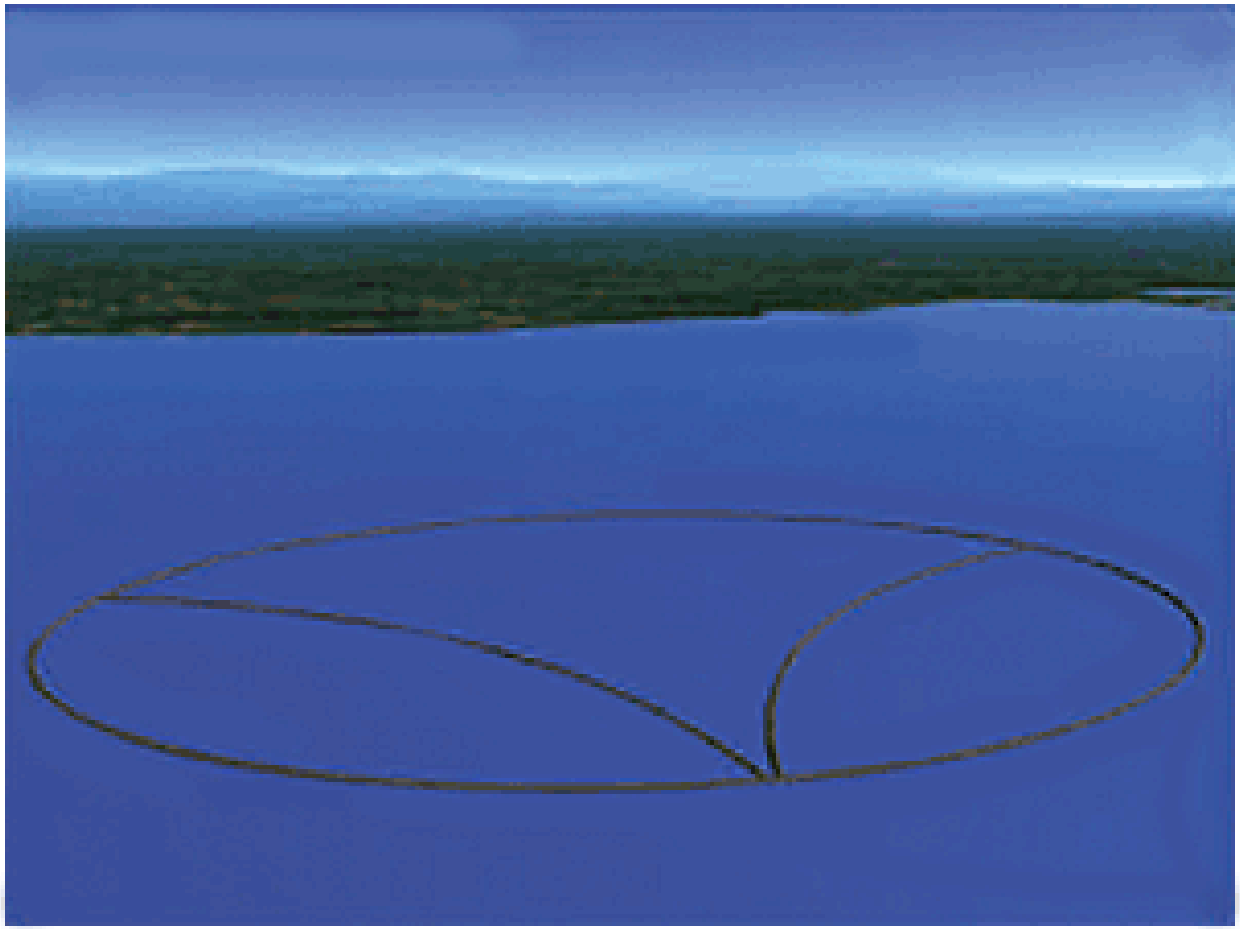
LaRance Tidal Barrage



Disadvantages of Tidal Barrage

- Prevents migration of anadromous fish
- Inhibits navagation
- Damages natural and scenic coastlines

Tidal Lagoon

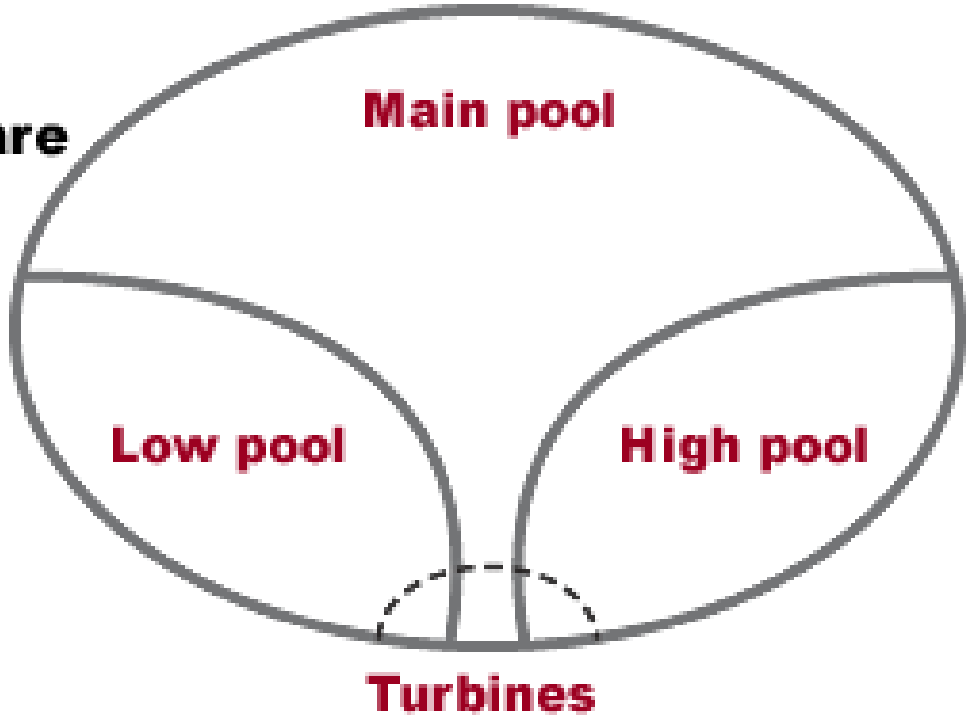


Artist's impression of a tidal lagoon 2 kilometers offshore.

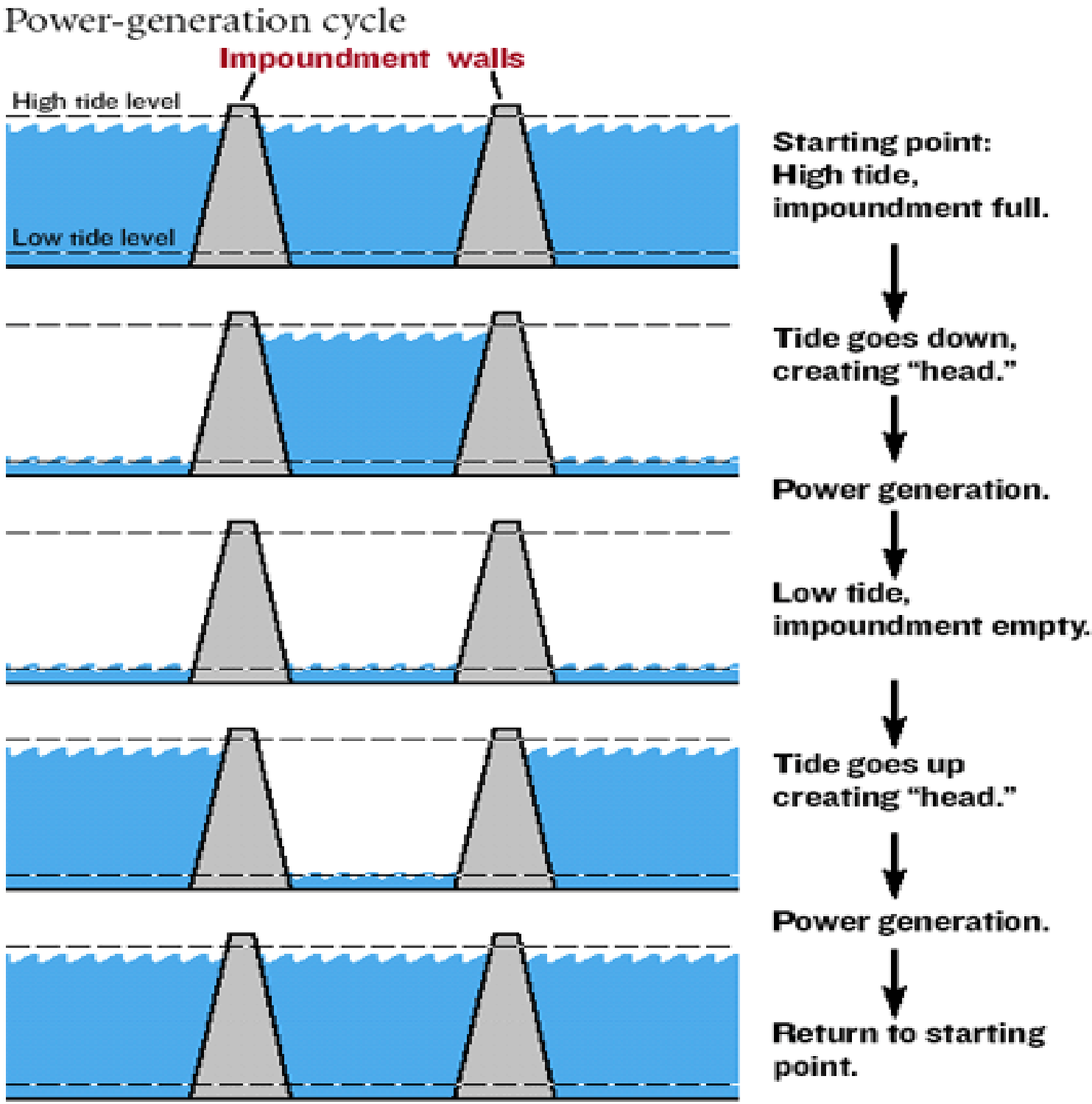
- http://www.forbes.com/global/2003/0721/042chart.html

Tidal Lagoon

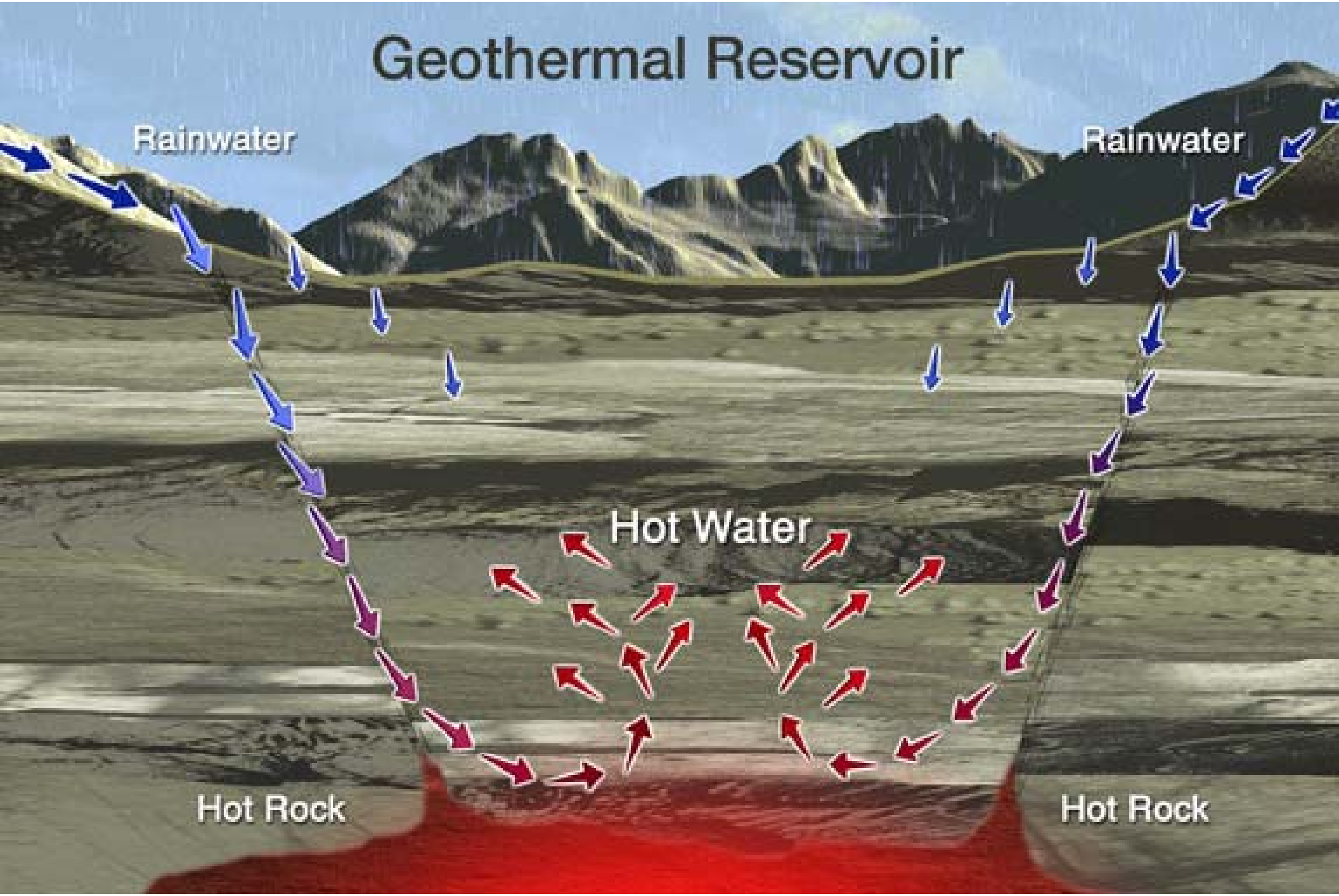
The lagoon is divided into three cells that are filled and emptied in sequence, thereby producing a more continuous output of electricity. Water goes in and out through the turbines.



- http://www.forbes.com/global/2003/0721/042chart.html



http://www.forbes.com/global/2003/0721/042chart.html

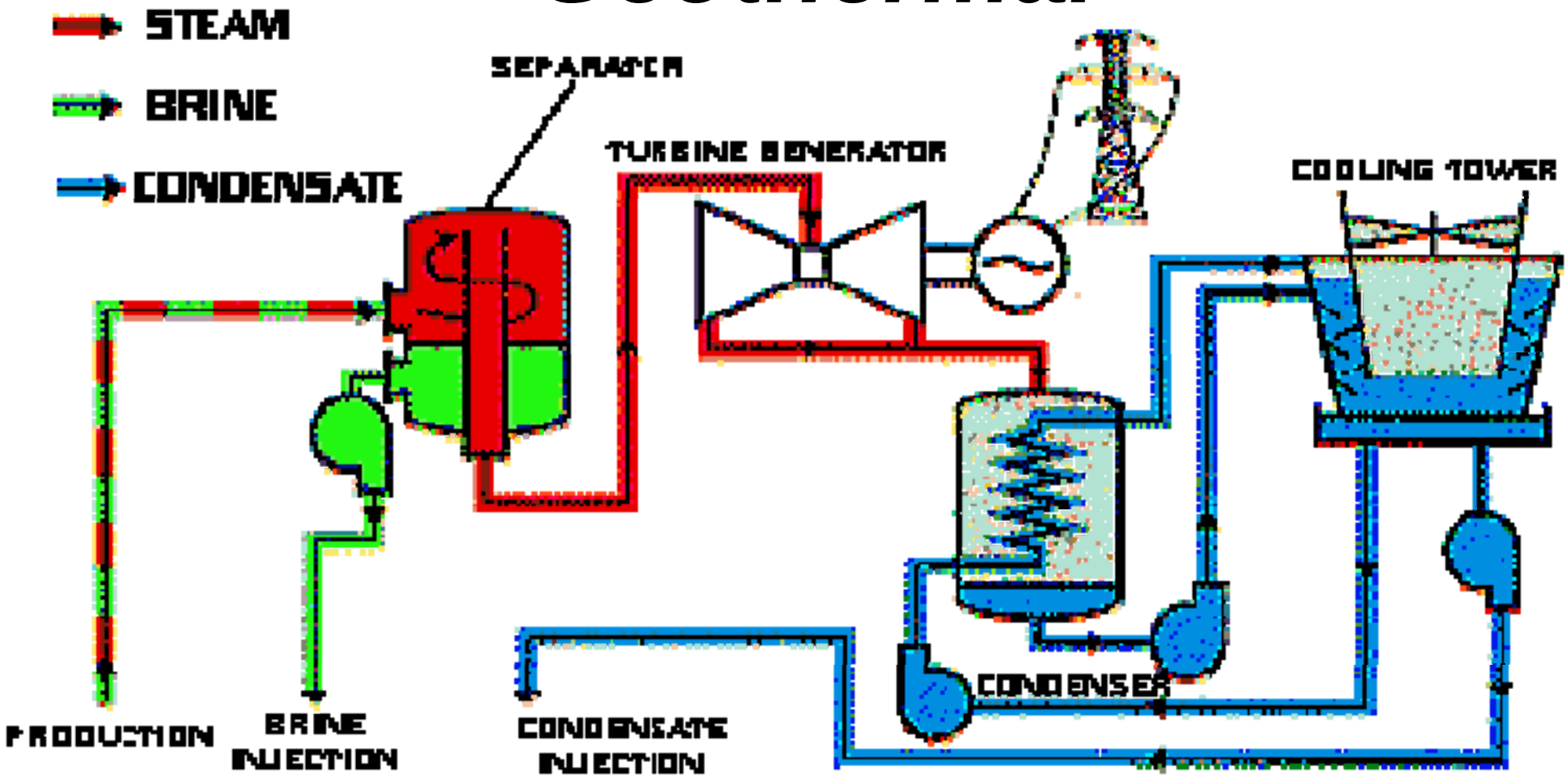


http://geothermal.marin.org/GEOpresentation/sld012.htm

Geothermal

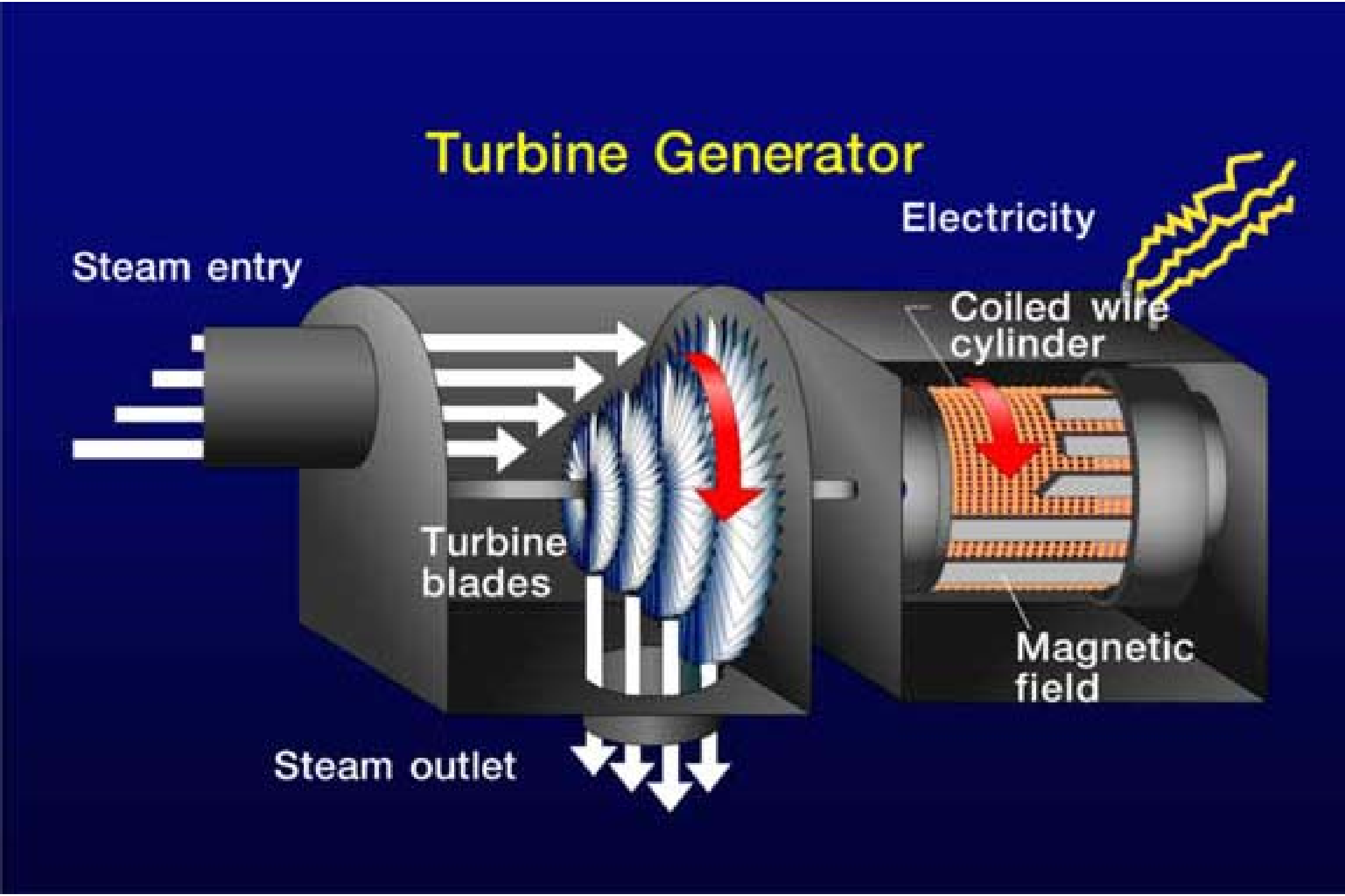
- Direct use for heating
  - Warm and hot sources of heat can be utilized for heat
- Generation of electricity
  - Requires hot source
- Water and hot-dry rock for both uses

Geothermal

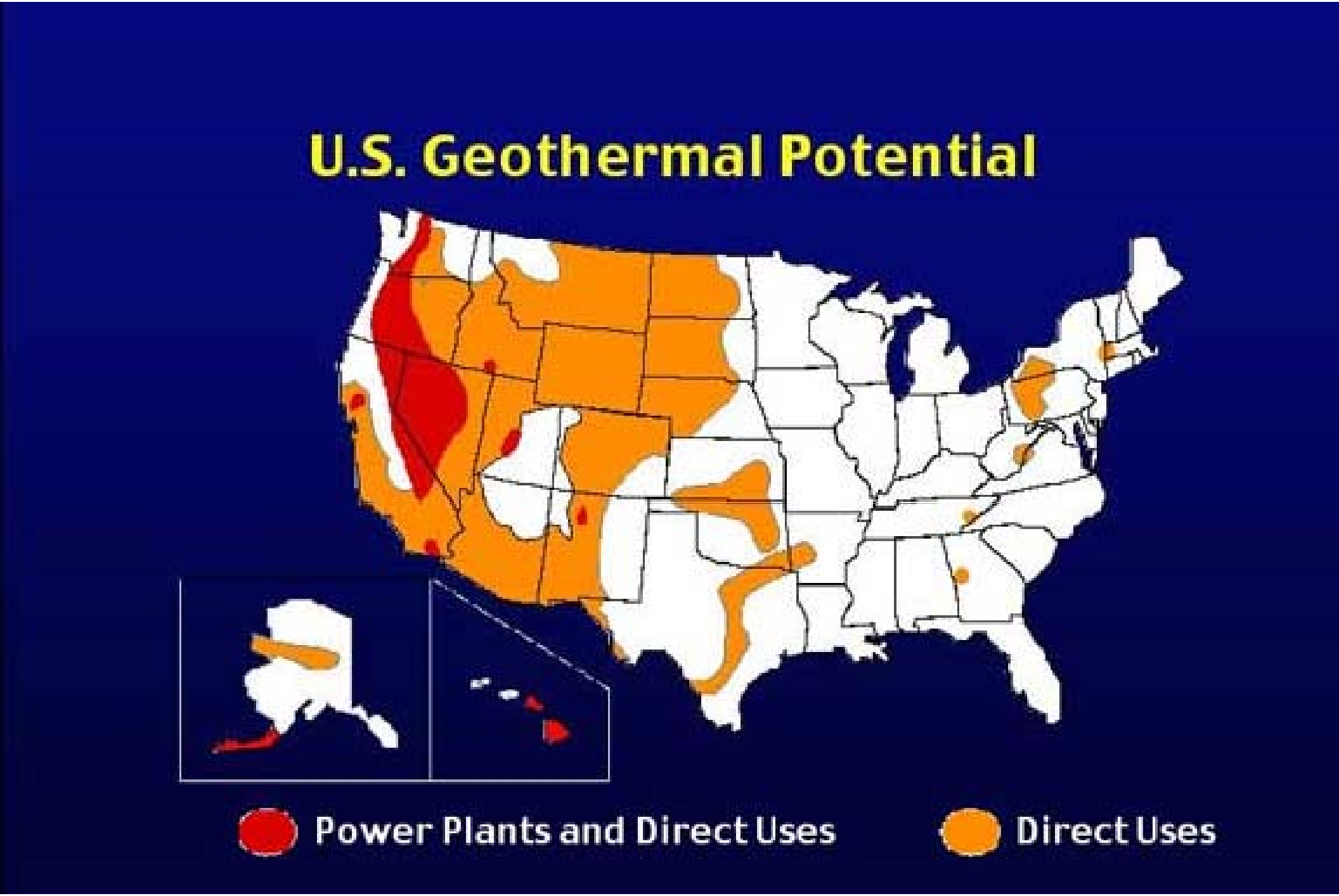


Single-Flash Cycle

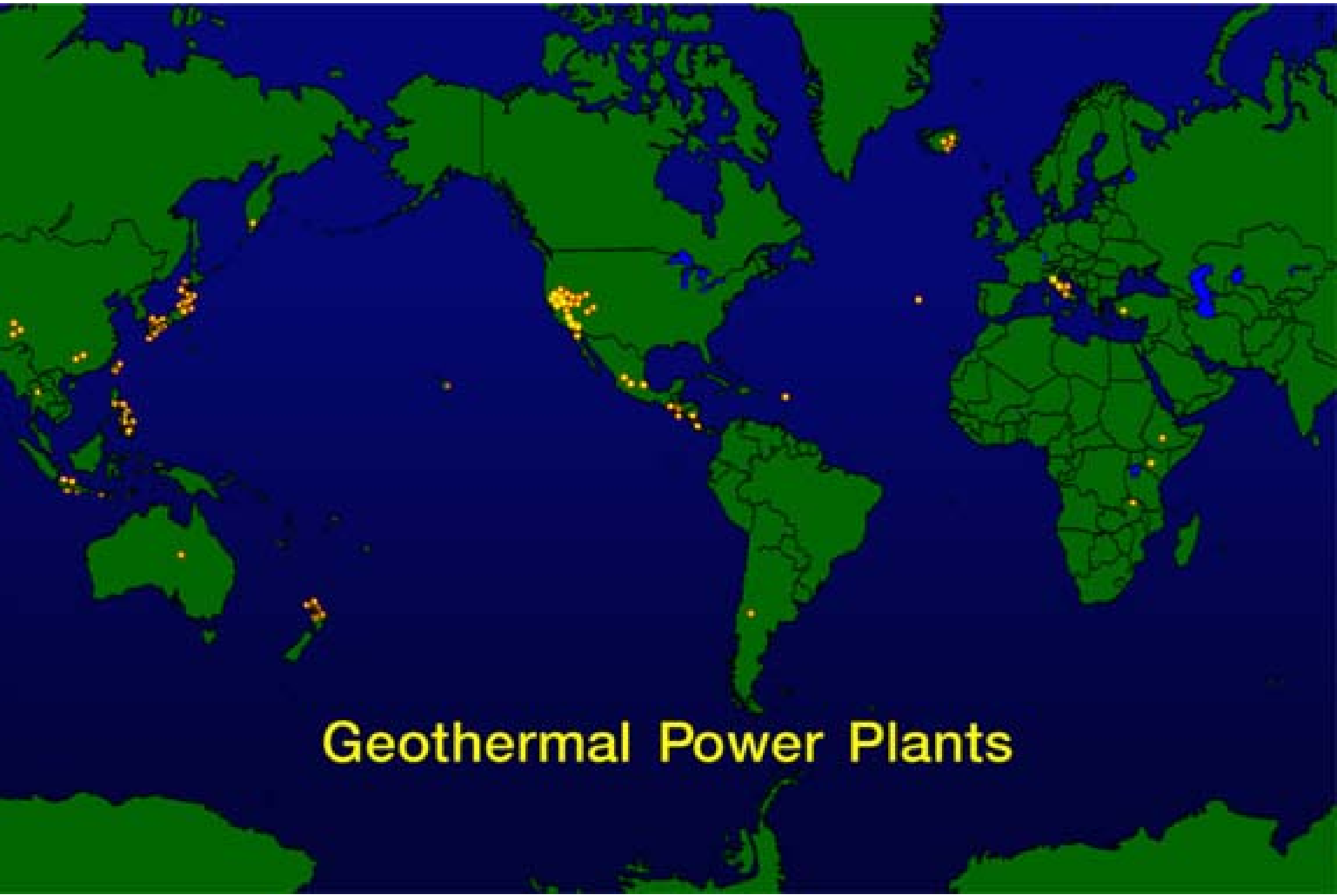
http://www.unocal.com/geopower/power.htm



http://geothermal.marin.org/GEOpresentation/sld038.htm



http://geothermal.marin.org/GEOpresentation/sld099.htm



http://geothermal.marin.org/GEOpresentation/sld069.htm

Geysers Dry Steam Geothermal Plant

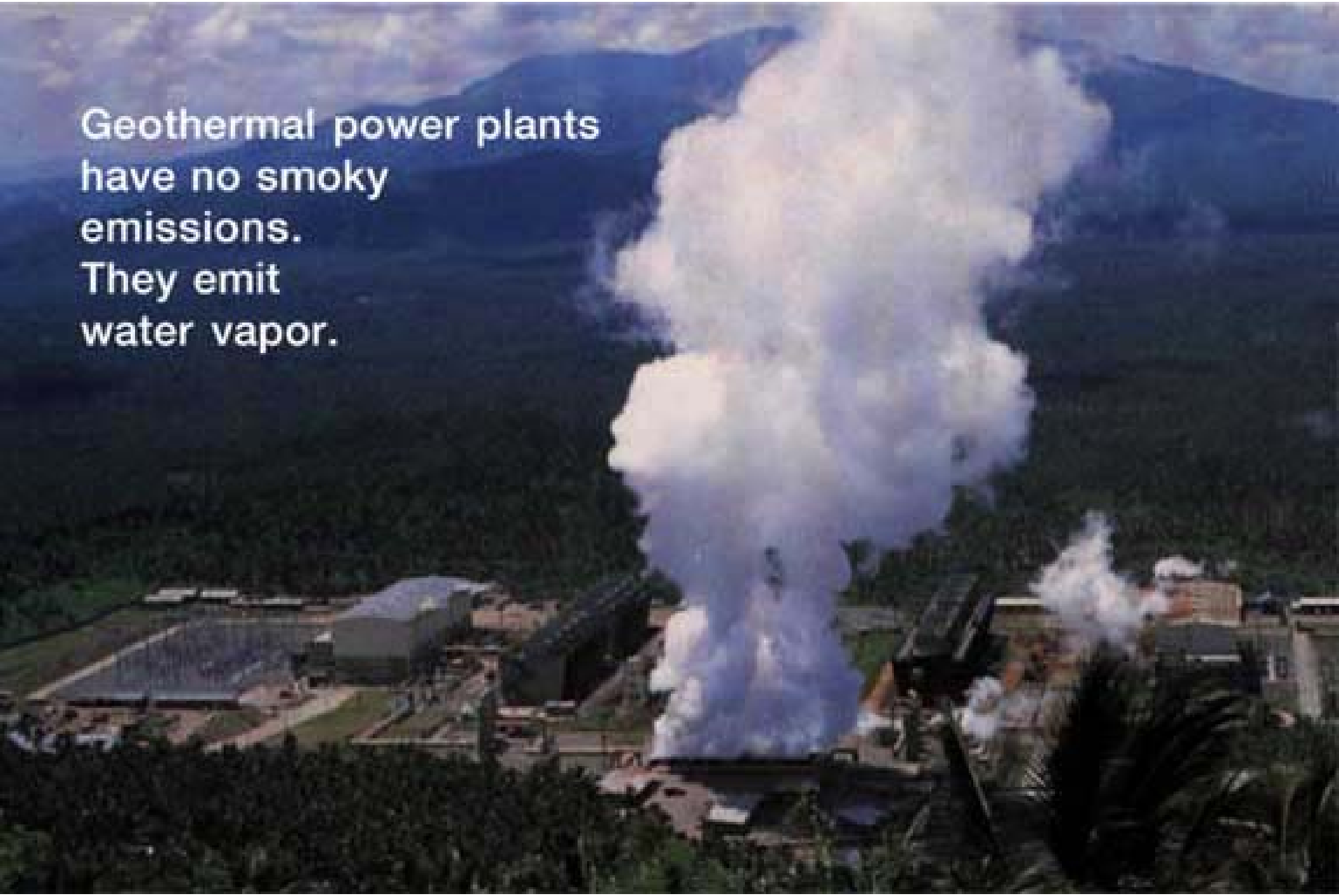
Largest plant
In the world

Produces
2000 megawatts
From 14 units

- http://www.ldeo.columbia.edu/users/menke/ENERGY/GEOTHERM/img16.html

Geothermal

- California about 10%
  - ‘The Geysers’ geothermal field
- Hawaii’s Big Island 25%
- The Philippines 27%

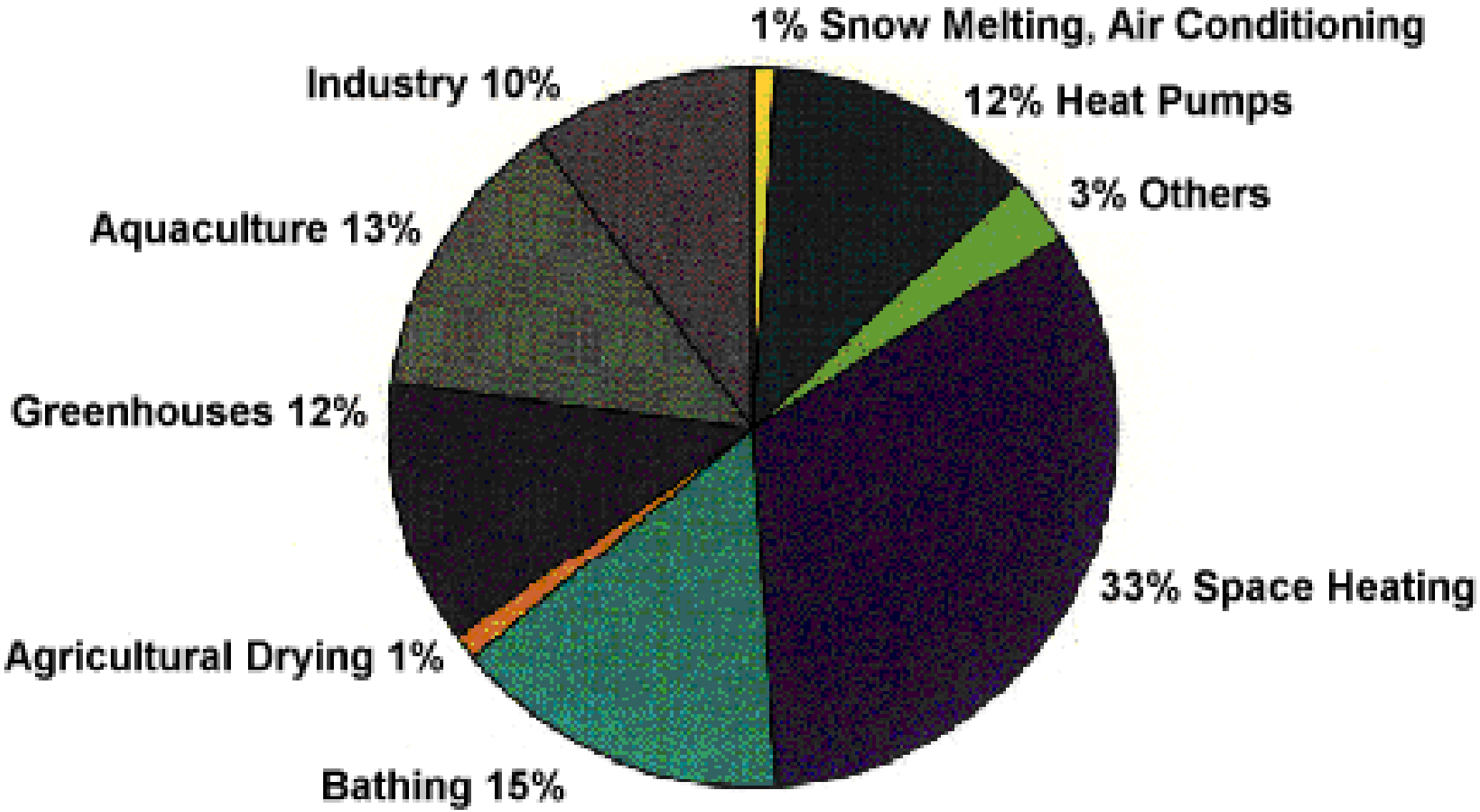


http://geothermal.marin.org/GEOpresentation/sld045.htm

Geothermal

- Advantages
  - No pollution
  - No CO_2 added to atmosphere
- Disadvantages
  - Water is corrosive
  - Steam is depleted from hot reservoirs

Direct-Heat Uses



http://www.worldbank.org/html/fpd/energy/geothermal/

Brady Hot Springs, northern Nevada, dries onions for Burger King

http://geothermal.marin.org/GEOpresentation/sld087.htm

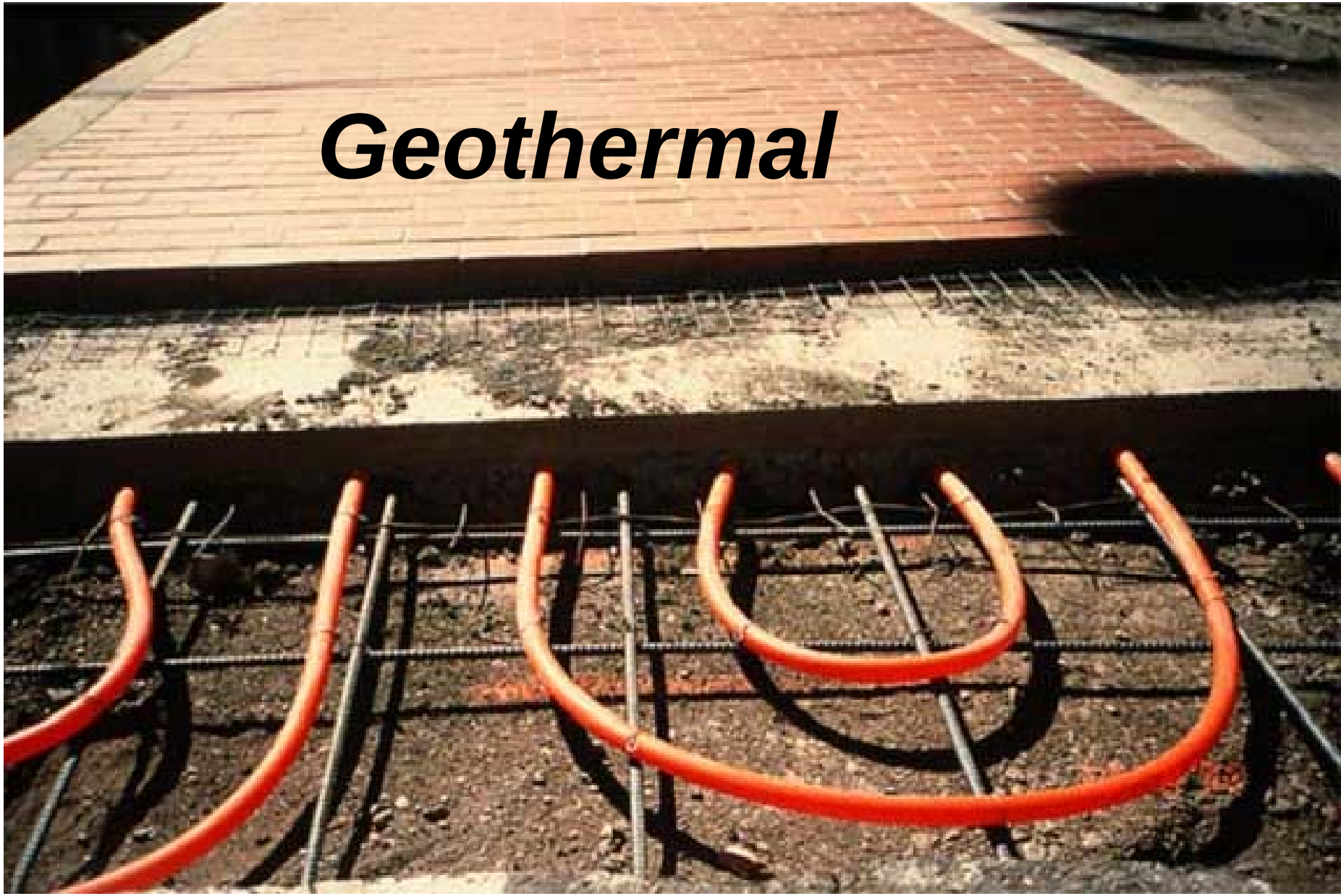
Reykjavik in the 1930s

http://geothermal.marin.org/GEOpresentation/sld094.htm

Reykjavik today

http://geothermal.marin.org/GEOpresentation/sld095.htm

Geothermal



http://geothermal.marin.org/GEOpresentation/sld088.htm

Orange tubing installed under sidewalks and roads, conducting geothermal-heated water to keep them from icing over in winter in Klamath Falls, Oregon

http://www.worldbank.org/html/fpd/energy/geothermal/

http://geothermal.marin.org/GEOpresentation/sld082.htm

http://geothermal.marin.org/GEOpresentation/sld085.htm

Drawbacks of geothermal energy

- Hot geothermal is a non-renewable resource
- Using hot geothermal water often is high maintenance, because the water is often acidic and contains high levels of dissolved mineral material that deposits upon conduction piping
- Disposal of heated, acidic water with dissolved solids can cause environmental impacts
- It is heat energy: not easy to transport

Hydrogen

- More energy than any other fuel
  - $2\ H_2 + O_2 \rightarrow 2\ H_2O + 572$ kJ heat energy
- WATER is the reaction product—clean!
- Can be distributed in presently existing pipelines
- But isn’t hydrogen DANGEROUS??

Hindenburg explosion

- http://www.altavista.com/web/results?itag=wrx&q=Geysers+Geothermal+Plant&kgs=1&kls=0

Hydrogen safety facts

- Escapes easier than natural gas
- Smaller molecules dissipate more readily
- Lighter than air so doesn’t form pools of invisible explosive gas
- Natural gas is explosive too

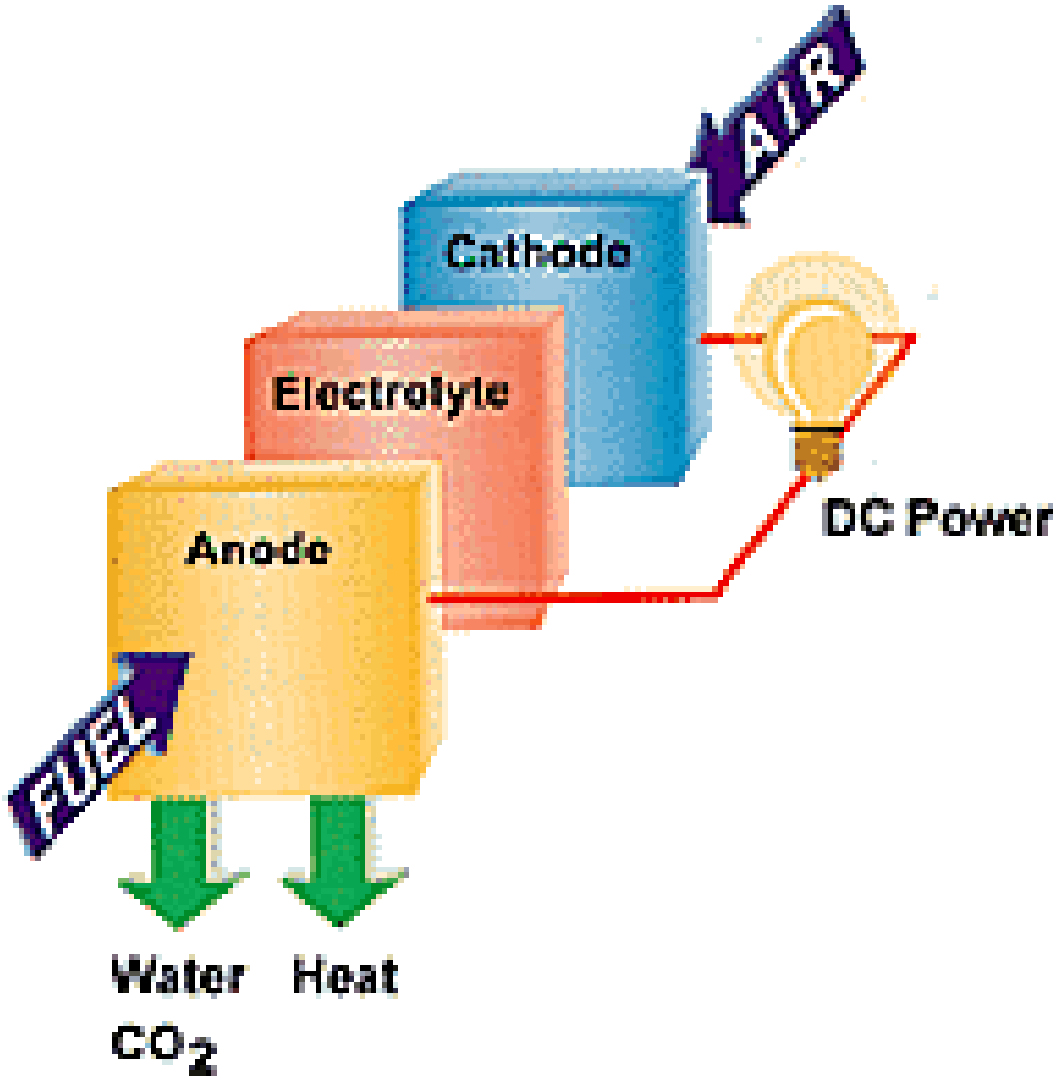
Hydrogen Technology

http://www.bmwusa.com/Standard/Content/Uniquely/FutureTechnologies/Hydrogen.aspx

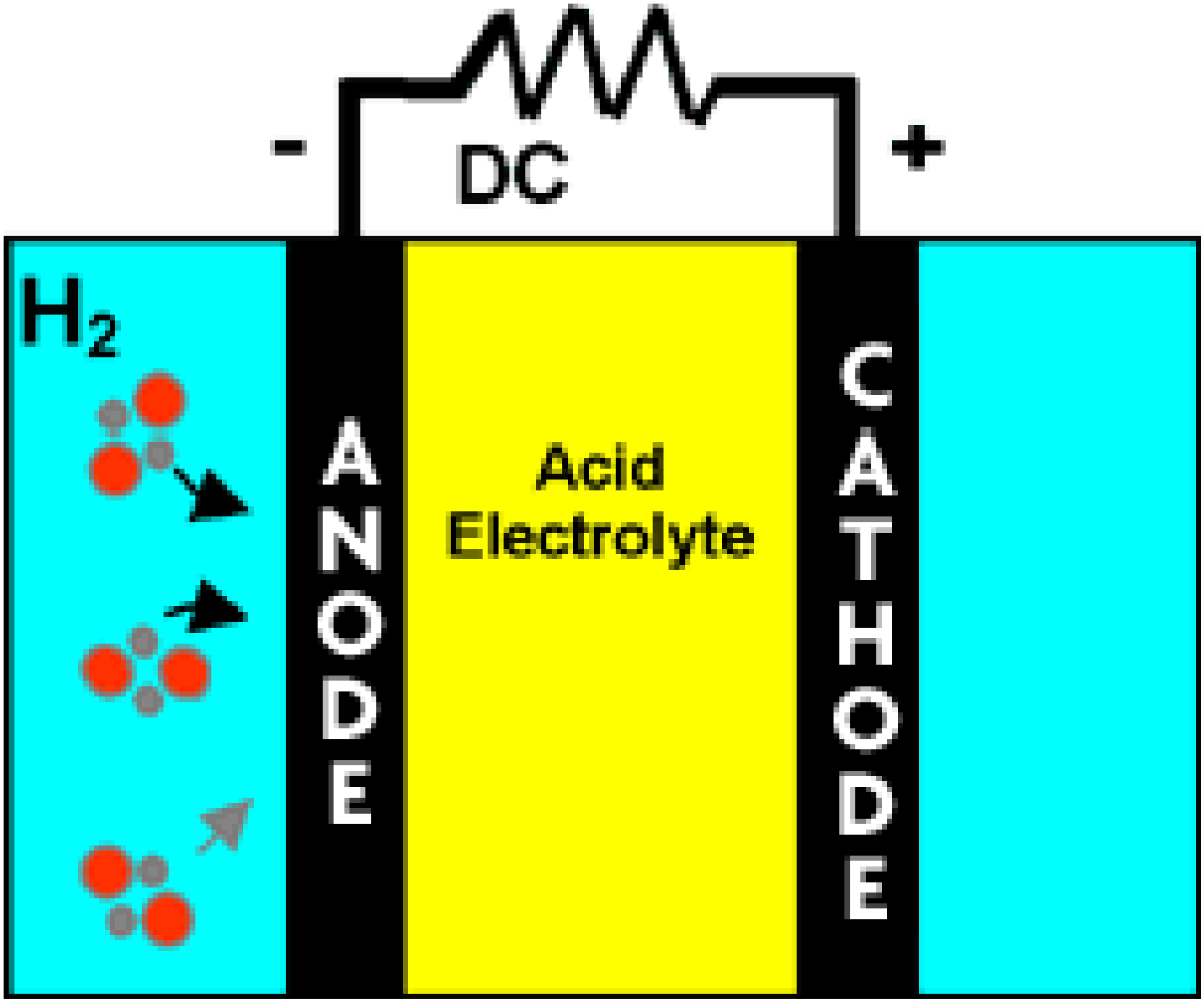
Fuel Cells

Release electrons in reaction of hydrogen and oxygen

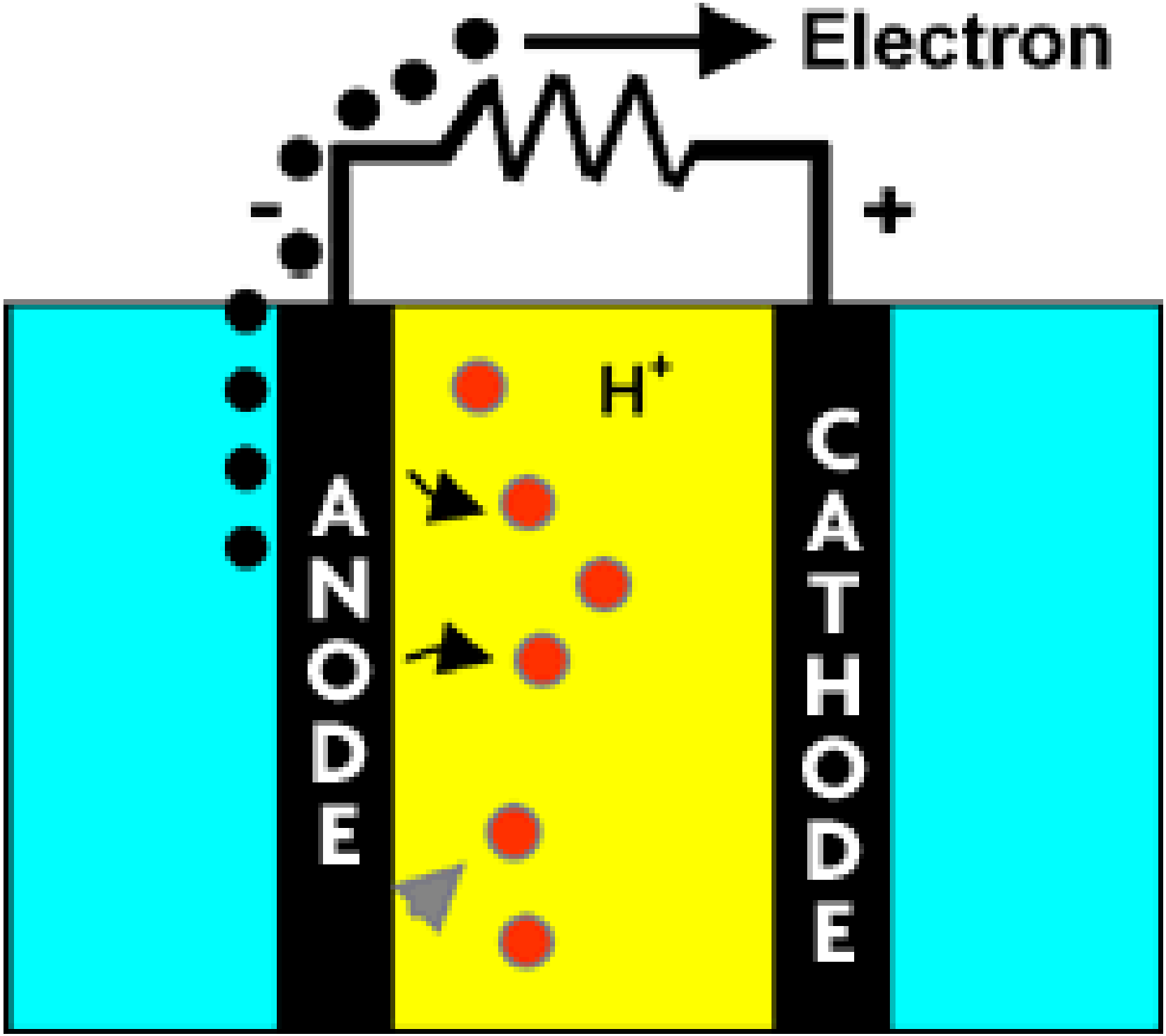
Does not release carbon dioxide



http://fossil.energy.gov/programs/powersystems/fuelcells/index.html



- http://www.worldpress.org/europe/0123iceland.htm



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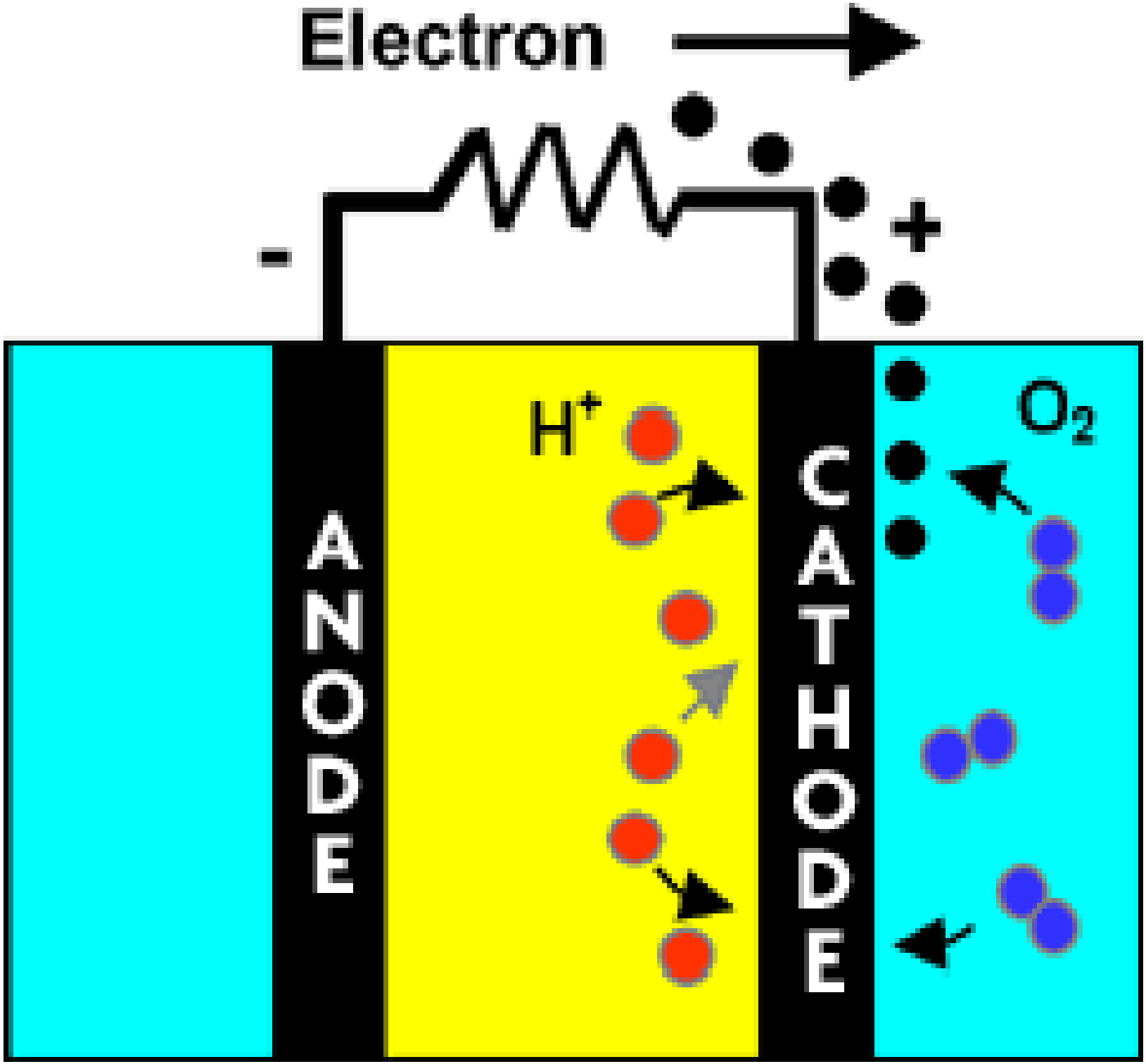

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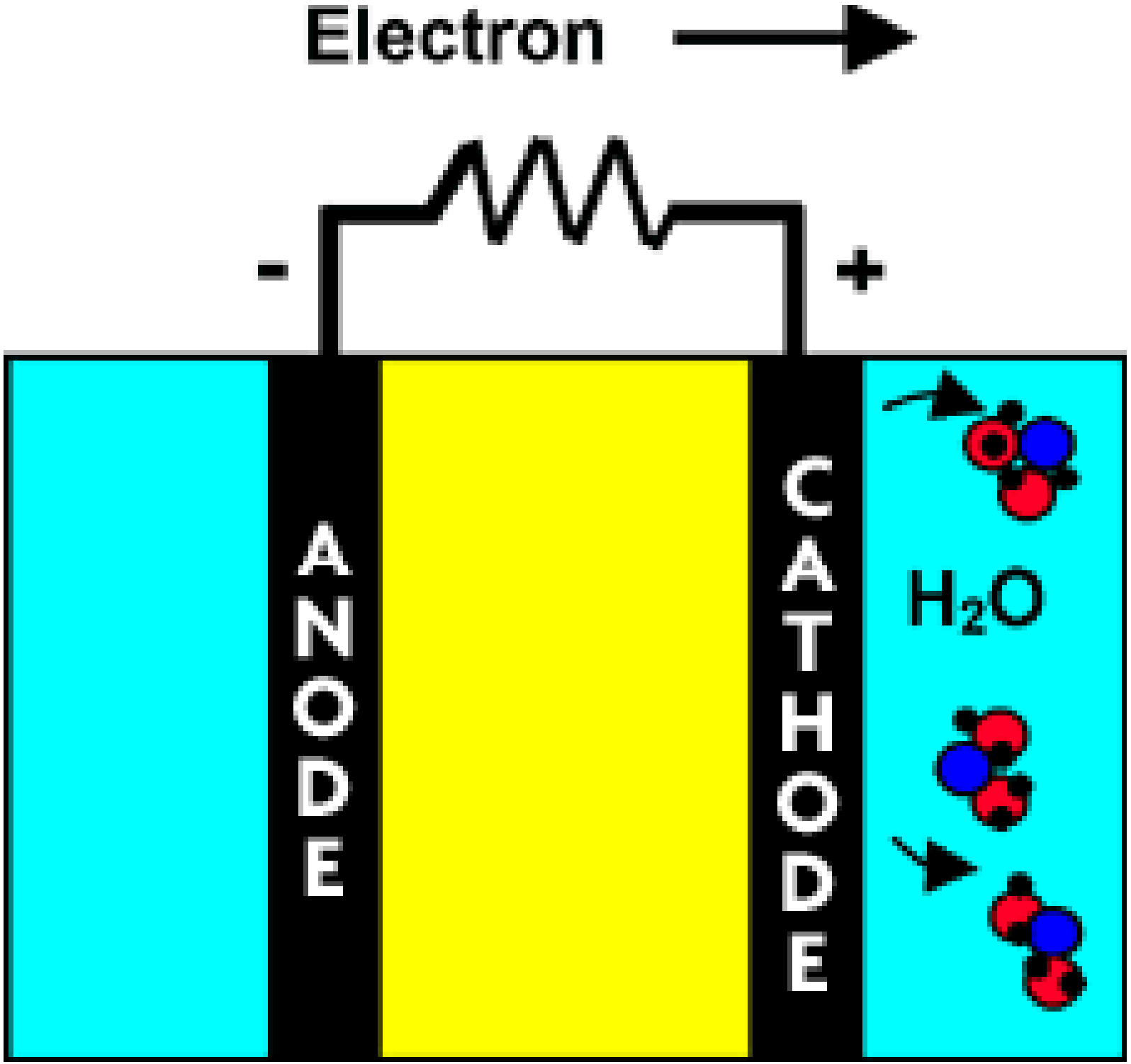


- http://www.worldpress.org/europe/0123iceland.htm

Fuel Cell Vehicles

- General Motors

Nuclear power

- Using fissionable isotopes to generate heat
- Use this heat directly, or use it to make steam to turn turbines and generate electricity

•http://www.iftp-berlin.de/english/en_news.htm

Advantages

- Minimal release of carbon dioxide, soot, sulfur and other acid compounds
- Small footprint of resource acquisition

  (mines impact less area than hydroelectric dams)
- Can be built near to areas that use electricity

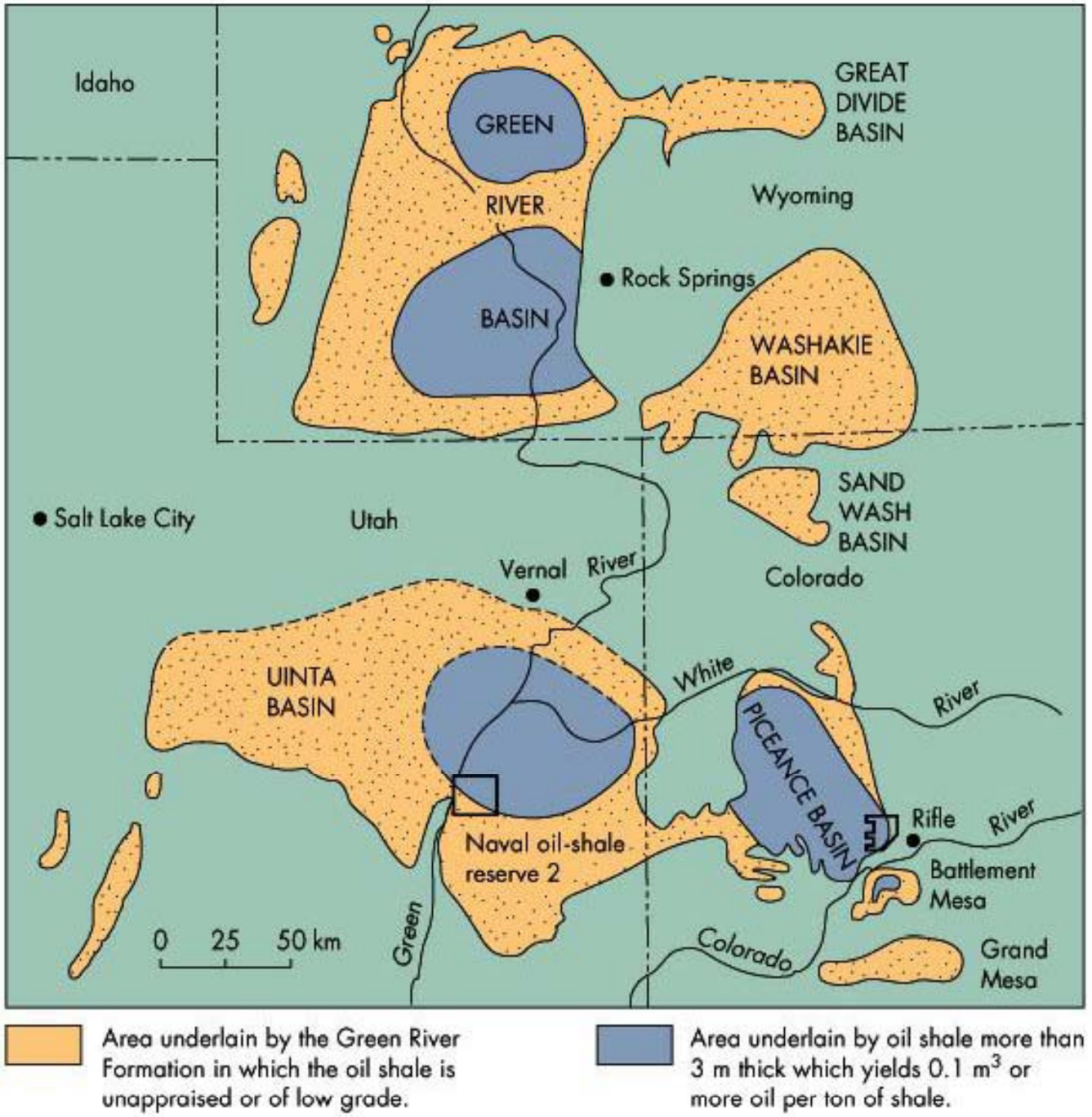
Disadvantages

- Release of radioactivity because of meltdown: extremely unlikely in routine operations—third generation of power plants are very reliable
- Sabotage by criminals: need security
- Disposal of radioactive waste
  - Low level generated in great volume: much is short-lived radioactivity
  - High-level spent fuel rods are dangerous for decades or millenia: but small in volume

Oil Shale

http://www.nerc.gov.jo/oil_shale_in_jordan.htm

Green River Oil Shale



http://www.utexas.edu/depts/grg/huebner/grg306c/graphics/oilshale.jpg

http://www.ldeo.columbia.edu/edu/dees/U4735/projections/pitman/5.55.tarsand.gif

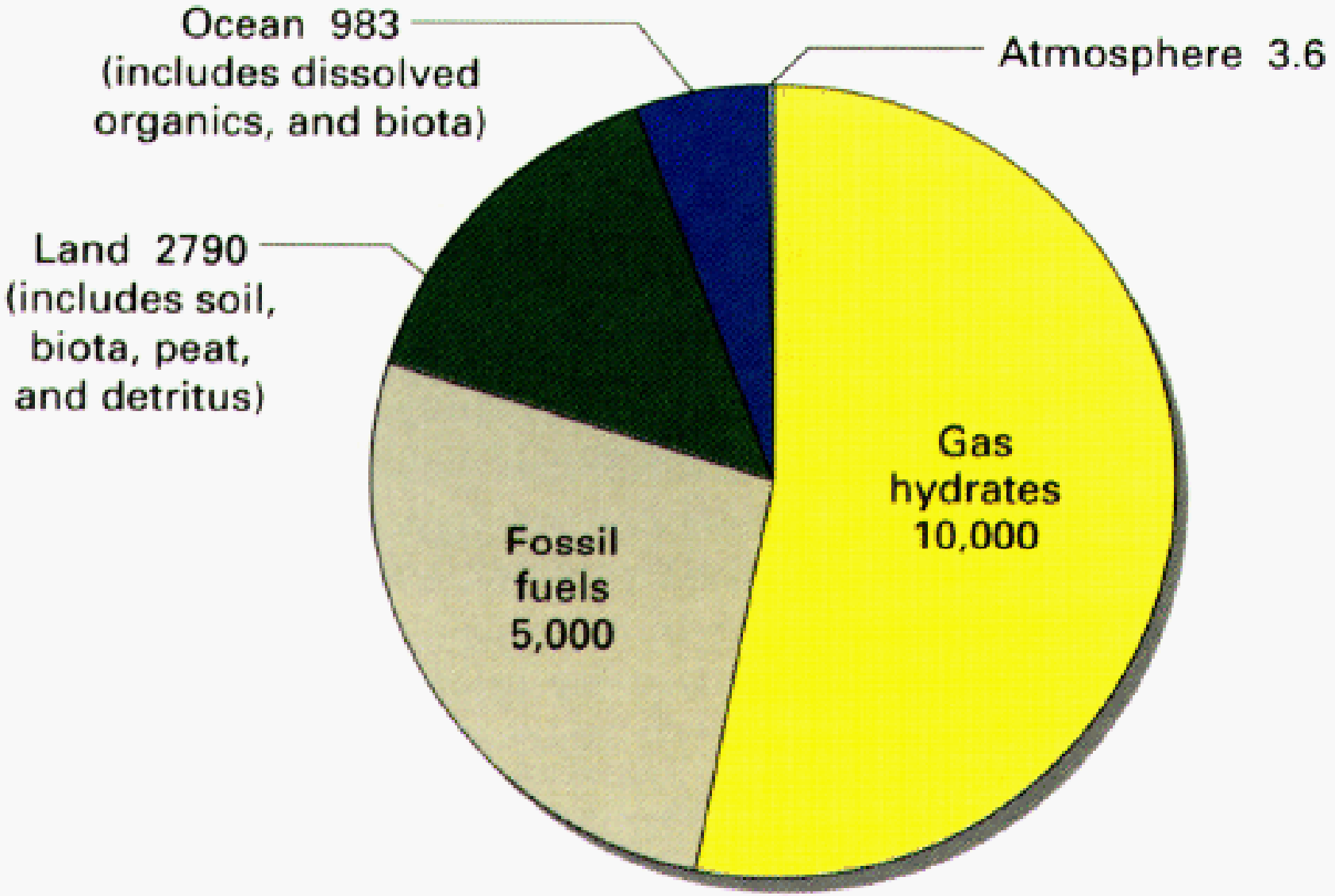
Athabasca Tar Sands

http://www.ldeo.columbia.edu/edu/dees/U4735/projections/pitman/5.55.tarsand.gif

http://www.protectowire.com/images/applications/profiles/electric-shovels/tar_sands_lg.jpg

Methane Hydrate

- Natural ices of methane and water
- Formed in permafrost and below 300 meters in ocean sediments
- Probably 100 times cubic feet of methane hydrate compared to natural gas in US
- Thaws to over 150 times its volume of methane



Distribution of organic carbon in Earth reservoirs (excluding dispersed carbon in rocks and sediments, which equals nearly 1,000 times this total amount). Numbers in gigatons (10^{15} tons) of carbon.

http://marine.usgs.gov/fact-sheets/gas-hydrates/gas-hydrates-3.gif

Coal Gasification

- Convert coal to methane
  - $C + 2\ H_2 \rightarrow CH_4$
- Use coal to make hydrogen
  - $C + H_2O \rightarrow CO + H_2$
- Convert coal to methanol alcohol
- All these are fuels that can be utilized today

Coal Gasification

- Removed most pollutants in coal
- More easily transported than solid coal
- More efficient than burning coal
- Can contain or eleminate CO_2
- Very promising technology