

# Alternative Fuel Sources

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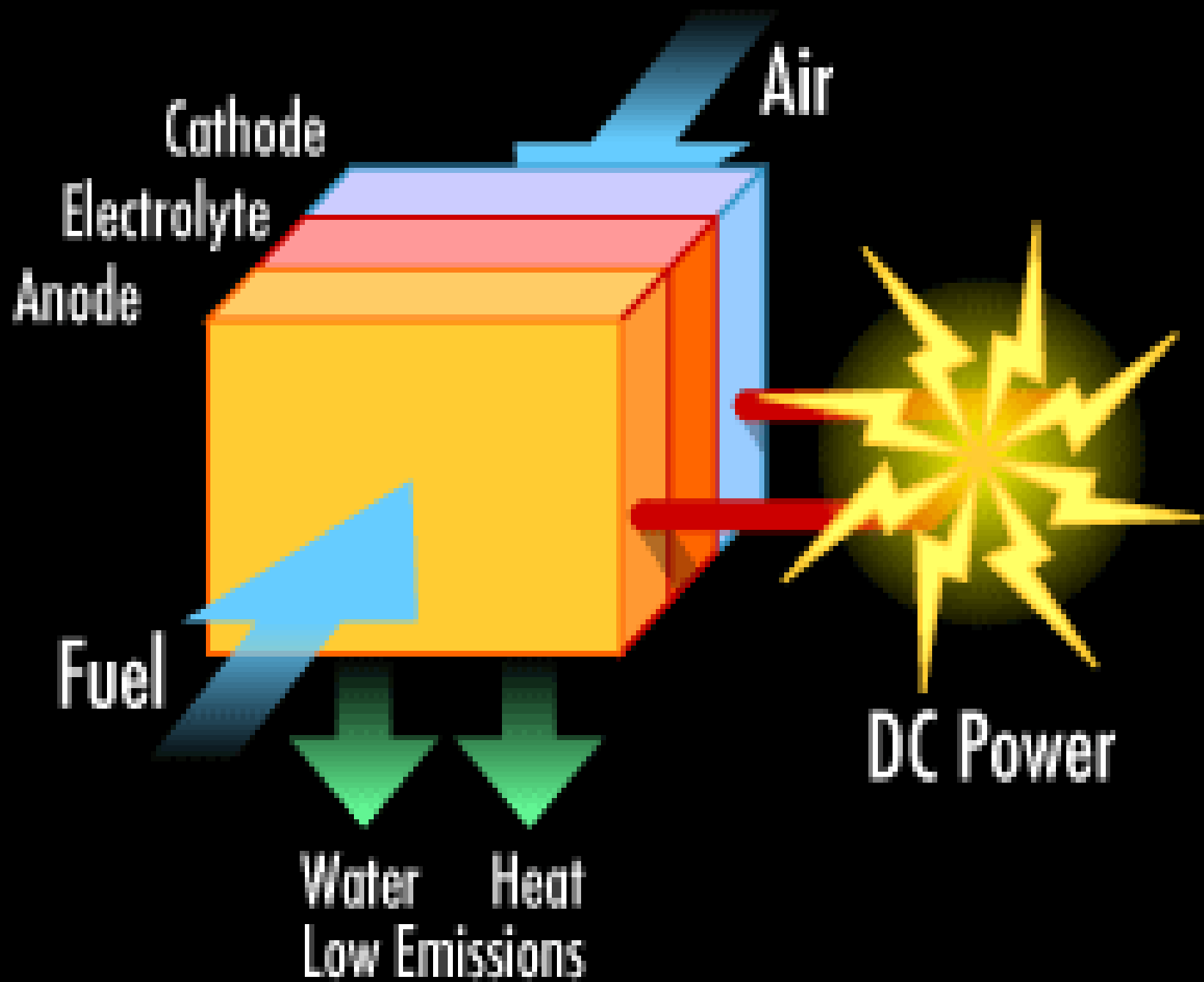


# Major Branches of Alternative Fuels.

- Fuel Cells
- Solar Energy
- Bio-diesel
- Cold Fusion Theory
- Fuel Economies:
  - Hydrogen Economy
  - Methanol Economy
  - Liquid Nitrogen Economy

# Fuel Cells

- Fuel Cell – an Electrochemical Energy Conversion Device
  - Converts hydrogen and oxygen into water, and in the process, produces electricity.
- Advantage over Batteries
  - A battery stores chemicals inside, and it converts chemicals into electricity, meaning that a battery eventually "goes dead".
  - In a fuel cell, chemicals constantly flow into the cell so it never goes dead.

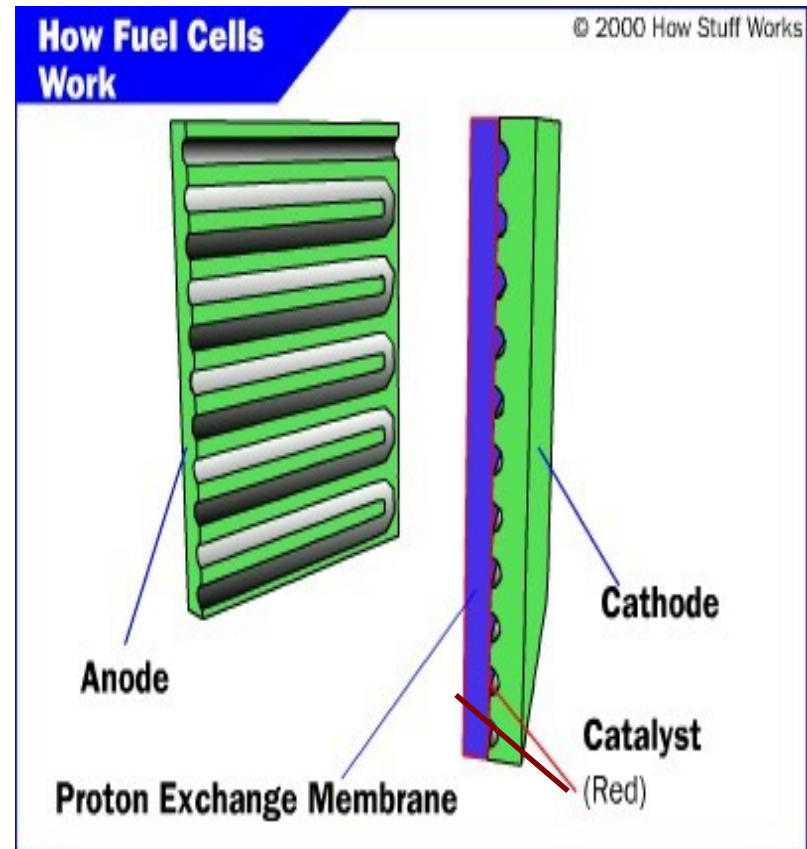


# Proton Exchange Membrane Fuel Cell

- Several different types of fuel cells, each using a different type of electrolyte.
- PEM fuel cells use simple Redox Reaction to create energy.
  - **Anode side (Oxidation):**  
 $2\text{H}_2 \Rightarrow 4\text{H}^+ + 4\text{e}^-$
  - **Cathode side (Reduction):**  
 $\text{O}_2 + 4\text{H}^+ + 4\text{e}^- \Rightarrow 2\text{H}_2\text{O}$
  - **Net reaction ( Redox ):**  
 $2\text{H}_2 + \text{O}_2 \Rightarrow 2\text{H}_2\text{O}$

# Parts of a Fuel Cell

- Anode – Negative part of fuel cell. Conducts electrons released by Oxidation reaction through circuit.
- Cathode – Positive part of fuel cell. Conducts electrons from circuit to catalyst to react with Hydrogen ions and Oxygen.
- Proton Exchange Membrane - conducts positively charged ions while blocking electrons.
- Catalyst - special material that facilitates the reaction of oxygen and hydrogen, usually made of Platinum.



# How Fuel Cells Work

- Hydrogen gas enters Anode, comes into contact with catalyst and undergoes oxidation reaction, releasing electrons and  $H^+$  ions.
- The electrons are conducted through a circuit connected to the cell, towards the cathode.
- Meanwhile, Oxygen gas enters Cathode, comes into contact with catalyst and forms  $O^-$  ions with a very strong negative charge. This attracts the  $H^+$  ions through the Proton Exchange Membrane.
- The Oxygen ions, Hydrogen ions and Electrons (after completing circuit), react to form a water molecule, which is released from the fuel cell.

# Pros and Cons of Fuel Cells

- Pros:

- Environmentally friendly
- Operate at low temperatures, not requiring containment structure.
- New technology, hence constantly improving architecture could help iron out some of the cons.

- Cons:

- One cell creates roughly 0.7 V of electrical potential, nowhere near enough.
- Hydrogen is not readily available.
- Does not “die out”.

# Solar Energy



- Use of photovoltaic cells to harness the energy of the sun's rays.
  - Cells convert photons from solar light into electricity
- Photovoltaic cells are made from semiconductors, usually silicon.
- Photons from solar light knock loose electrons from semiconductor to create a flow of electrons (electricity).

# How Photovoltaic Cells Work

- Part of the Solar cell uses Impure Silicon with added Phosphorus atoms.
  - Contains more free electrons to carry more current.
  - Since Phosphorus contains 5 electrons and Silicon wants to share 4, one electron remains free. This electron gets knocked out as photons strike atoms.
- Solar cell also uses Impure Silicon with added Boron atoms.
  - Contains less free electrons, more holes in formation
  - Since Boron contains 3 electrons, and Silicon wants to share 4, one gap remains empty.
- When put together, phosphorus electrons break free and try to fill gaps on the boron side.

## How Photovoltaic Cells Work – Pt. 2

- This rush of electrons to fill the empty gaps creates an electric field, preventing loose electrons (knocked loose when photons hit cell) from flowing in a given direction, forming a hill so that all electrons flow the same way, creating controllable current.



# Pros and Cons of Solar Energy

- Pros:

- Environmentally Friendly
- Cheaper than conventional electricity in the long run.
- Produce large amounts of energy using a surprisingly small amount of land.

- Cons:

- Unpredictable source of energy (cloudy weather, storms)
- Initial installation is very expensive

# Biodiesel

- Alternative to diesel made from biological ingredients.
  - Usually made of plant oils containing fats.
  - Raw plant oils must undergo chemical reactions to make fuel, and even then must be combined with conventional diesel to create effective, safe, fuel.

# Pros and Cons of Biodiesel

- Pros:

- Environmentally Friendly
- Helps to lubricate engine through which it flows, preventing wear and tear.
- Safer than normal diesel

- Cons:

- Not 100% fossil-fuel free
- Expensive to make and distribute (due to long creation process).
- Currently expensive for consumer, due to lack of demand. May get cheaper.

# Cold Fusion Theory

- Nuclear fusion reaction that occurs well below the temperature required for thermonuclear reactions. May occur near room temperature and atmospheric pressure.
- Nuclear Fusion normally takes place in the Sun's core at temperatures of millions of degrees.
  - hydrogen atoms are compressed together by elemental forces to form helium and a massive amount of energy.

# Overview of Cold Fusion



- When water is electrolyzed in a calorimeter, the release of energy can be measured.
- Scientists Fleischmann and Pons said they observed that when a palladium cathode, platinum anode and heavy water (deuterium oxide) were used instead of regular water, the amount of energy released was very large.
- The experiment was attempted by different laboratories around the world, with mixed results
  - Some scientists reported that the experiment was irreproducible, whereas others reported success in reproducing reaction

# Viability of Cold Fusion

- Due to conflicting sources and controversial data, combined with a lack of definitive evidence, it is hard to prove if reaction has actually occurred.
  - Nuclear detection systems have revealed nuclear reaction must have occurred, but no clear indication of what reaction has actually occurred
  - Variable results from scientists attempting to reproduce experiment have led to wide disbelief in theory
  - No studies show that gamma rays were released that would remain consistent with amount of heat released

# Pros and Cons of Cold Fusion

- Pros:

- Releases HUGE amounts of energy, more than any known source of harness able energy.
- Safer than Nuclear fission, in terms of radiation released and danger of nuclear explosion

- Cons:

- Unproven to even exist. Even if proof is brought forth, could be a long time till it becomes a usable form of energy.
- Still releases gamma radiation, which could damage the environment if leaked from power plant.

# Economies

- Theories involving all future reliance on fossil fuels to be changed over to certain other chemicals.
- Popular hypothesized economies:
  - Hydrogen Economy
  - Methanol Economy
  - Liquid Nitrogen Economy

# Hydrogen Economy

- Hydrogen fuel would be manufactured from renewable energy sources replacing gasoline, kerosene, and diesel for transportation.
- Any carbon-containing energy sources used in the manufacture of the hydrogen would take place in an environment allowing for no carbon to escape from manufacturing process.
- The end use of the hydrogen would be direct combustion in heat engines, or as fuel in fuel cells, producing only water vapor, and no greenhouse gases.

# Methanol Economy

- Methanol manufactured by recycling carbon dioxide emissions and adding hydrogen gas. Also possible via oxidation of methane with oxygen.
- Methanol would be used directly as fuel or in a direct methanol fuel cell.
- Advantages over Hydrogen:
  - No construction of new hydrogen infrastructure required. Can simply be cycled into current gasoline structure.
  - User friendly, not requiring large equipment to remain in a pressurized state.
  - Allows for recycling of emissions that would normally be released into the atmosphere.

# Liquid Nitrogen Economy

- Liquid nitrogen generated by cryogenic coolers that liquefy the main component of air, nitrogen gas. Cooler powered by renewable generated electricity (solar power, wind power, etc).
- Liquid nitrogen distributed and stored in insulated containers. The requirements of storage prevent the use of pipelines as a means of transport.
- Liquid nitrogen consumption is simply production in reverse. The cryogenic heat engine offers a way to power vehicles and generate electricity by reversing process of liquefying.

# Pros and Cons of Fuel Economies

- Pros:
  - Once up and running, could provide environmentally friendly and stable energy
  - Could run for an infinitely long time, since large amounts of hydrogen, nitrogen and methanol available in environment.
- Cons:
  - Require current infrastructure to be replaced by new infrastructure, costing large amounts of money.
  - Still hypothetical. Problems exist with each economy (cost, difficulty of manufacture, difficulty in distribution, etc.)

# Conclusion

- No clear source of alternate energy currently viable.
- Each source has potential to help alleviate reliance on fossil fuels and save environment.
- Maybe in another 10-20 years, an alternate fuel source could be proven as reliable and possible, leading to a replacing of current infrastructure.
- Placing new fuel source could cost billions of dollars, and cannot happen for at least another 50-60 years.

# Works Cited

- Fuel Cells - <http://auto.howstuffworks.com/fuel-cell.htm>
- Solar Power - <http://science.howstuffworks.com/solar-cell.htm>  
<http://www.solarsense.com/Advantages/Advantages.html>
- Biodiesel - <http://auto.howstuffworks.com/biodiesel.htm>  
<http://en.wikipedia.org/wiki/Biodiesel>
- Cold Fusion - [http://www.freeglossary.com/Cold\\_fusion](http://www.freeglossary.com/Cold_fusion)  
[http://www.alternativescience.com/cold\\_fusion.htm](http://www.alternativescience.com/cold_fusion.htm)  
[http://en.wikipedia.org/wiki/Cold\\_fusion](http://en.wikipedia.org/wiki/Cold_fusion)
- Economies - [http://en.wikipedia.org/wiki/Methanol\\_economy](http://en.wikipedia.org/wiki/Methanol_economy)  
[http://en.wikipedia.org/wiki/Hydrogen\\_economy](http://en.wikipedia.org/wiki/Hydrogen_economy)  
[http://en.wikipedia.org/wiki/Liquid\\_nitrogen\\_economy](http://en.wikipedia.org/wiki/Liquid_nitrogen_economy)