

Alternative Energy Technology

I. Sources

- A. Solar—both direct and conversion
- B. Biomass—harvesting plants that caught Sun's energy
- C. Water and Wind—rivers and tides
- D. Geothermal—using heat to make steam
- E. Other fossil fuels—coal gasification, oil shale, tar sands, methane hydrate
- F. Advancing modern technologies—hydrogen, fuel cells, alcohol

II. Solar energy

- A. Direct use as heat
 - 1. Space heating
 - 2. Water heating
- B. Photovoltaic
- C. Disadvantages
 - 1. Inefficient—10%
 - 2. Balance of system components
 - a. batteries
 - b. inverter
 - c. cell racks

III. Biomass fuel

- A. Directly burned
 - 1. plant roughage
 - 2. Plant sources of oil
 - a. Sunflower seed oil
 - b. Peanut oil
 - c. canola
- B. Converted to alcohol
 - 1. Internal combustion engines can be adjusted to run on alcohol
 - 2. Fermentation of corn
 - a. Methanol
 - b. Ethanol
- C. Converted to methane
- D. Disadvantage
 - 1. Lack of arable land where power is needed
 - 2. Low percent efficiency 3%
- E. Disadvantages may outweigh advantages, however could be exploit energy source to dispose of waste roughage and food oil

IV. Water power

- A. 9% of present US electricity production
- B. Potential energy converted to kinetic to mechanical energy that drive turbines that generate electricity

V. Wind power

- A. Created by Earth's rotation and the sun
- B. Utilized for centuries to pump water and grind grain
- C. Presently utilized to generate electricity
 - 1. Nearly 7% of Germany's power from wind generators
 - 2. Denmark presently generates 20% of its power by wind
 - 3. US could easily gain 10% of its electricity from wind

VI. "Lunar" Power

- A. Tides twice daily influx of water
- B. Harness for hydroelectric power where range is significant
- C. Disadvantages
 - 1. Only twice a day
 - 2. Impact to scenic coastlines
- D. Largest tidal barrage in place St. Malo, France 250 MW
 - 1. 14 meter range
 - 2. Block navigation
 - 3. Interfere with marine life
 - 4. Alter shoreline
- E. New idea to build cofferdam lagoon offshore
 - 1. Turbines at bottom of wall
 - 2. Let water in at high tide—generate power
 - 3. Let water out at low tide—generate power
 - 4. Perhaps 20 sites worldwide conducive

VII. Geothermal Energy

- A. Radioactive decay and gravitational pressure create -interior heat
- B. Electrical generation
 - 1. Steam or hot water near surface
 - a. Generate just like coal-heated water
 - b. Advantages
 - 1) no pollution
 - 2) no CO₂ added to atmosphere
 - c. Disadvantages
 - 1) water is corrosive, mineralized
 - 2) steam is rapidly depleted
 - d. present utilization
 - 1) 27% of Philippines powered by geothermal electricity
 - 2) 25% of Big Island, Hawaii

2. hot-dry rock
 - a. pump in cold water
 - b. pump out heated water
- C. direct use of heat
 1. dehydration
 2. space heating
 - a. homes and workplaces—80% of Reykjavik, Iceland
 - b. Greenhouses, aquaculture, municipal projects

VIII. Alternative fossil fuels

A. Oil Shale and Tar Sands

1. Oil shale contains kerogen—
 - a. pre-petroleum: incompletely cooked
 - b. can yield up to 50 gallons of oil/ton upon heating
 - c. Green River Formation: Wyoming, Colorado, Utah contains 130 billion bbl (5x proven petroleum reserves in US)
 - d. exploited in 1920s, until petroleum became available and cheap
 - e. not economic at today's production cost
 - f. contains less H₂ than petroleum, more sulfur and nitrogen
 - g. waste of stripped shale greater volume than original
2. Tar Sands contain asphalt-like bitumen
 - a. 10-15% bitumen in tar sand
 - b. largest deposit in Alberta, Canada: Athabasca
 - c. heating in-situ to 80° C allows it to be pumped
 - d. heating to 500° C converts to petroleum

B. Coal gasification

1. process
 - a. Coal to methane: $C + 2 H_2 \rightarrow CH_4$
 - b. Coal makes hydrogen: $C + H_2O \rightarrow CO + H_2$
 - c. Converted to methanol, which can be made into gasoline-like liquid fuel
2. Advantages
 - a. Removes majority of pollutants in coal
 - b. More easily transported than solid
 - c. More efficient than burning coal (30% vs 50%)
 - d. Containment or elimination of CO₂
3. Very promising developing energy technology

IX. Hydrogen

- A. $\text{H}_2 + \text{O}_2 \rightarrow \text{H}_2\text{O} + 572 \text{ kJ}$
- B. More energy than any other fuel
- C. Clean: water is product of reaction
- D. Transportation infrastructure already in existence
- E. Safer in terms of accidents than natural gas
 - 1. Doesn't pool as flammable vapor
 - 2. Dissipates more easily

X. Fuel Cells

- A. Release electrons by reacting hydrogen and oxygen to form water
- B. Also can react methane and air to release electrons, products are water and heat
- C. Advantages
 - 1. Less carbon dioxide released than by burning methane
 - 2. Direct hydrogen does not release any
 - 3. Other pollutants not released
 - 4. Easily turned on and off with need of use

XI. Methane hydrate

- A. Natural ices of water and methane
 - 1. Form in tundra permafrost areas
 - 2. Form beneath sea at depths greater than 300 m
- B. US probably has over 100 times as much methane hydrate than natural gas
- C. Methane hydrate thaws to form 160 times as much gas as ice