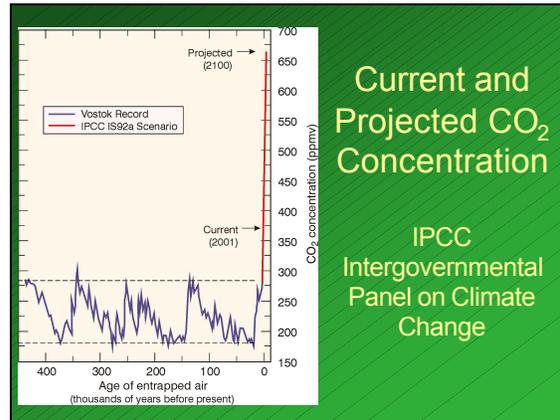
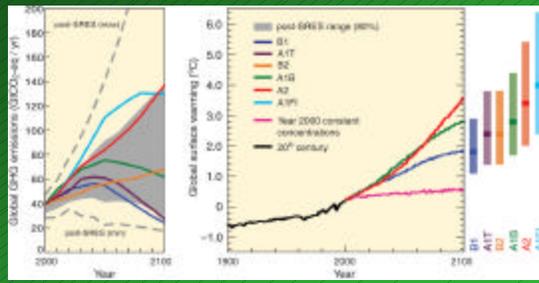


Global Warming 2

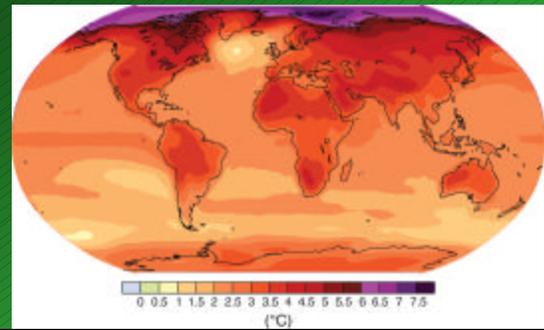
What will happen ?



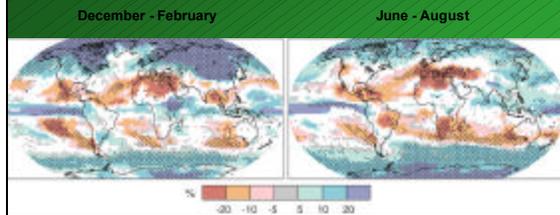
Projected Global Temperatures



A1B – Moderate Scenario



Change in Precipitation



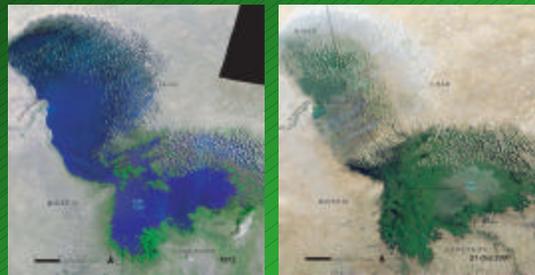
Amazon Drought - 2005



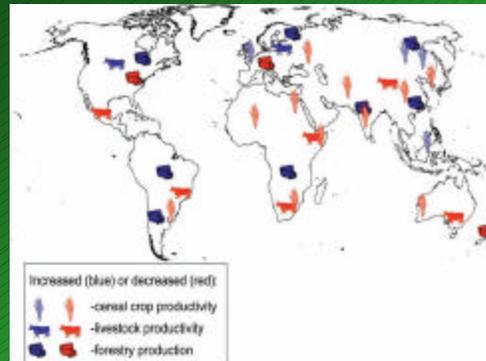
Lake Chad – Africa's Largest Lake

1972

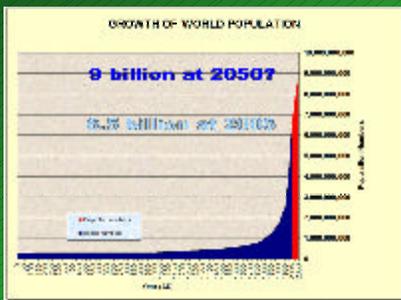
2001



Food Production 2050



How Will We Feed Them?



Current Food Shortages

- Price of food increasing
- Rice tripled in price
- Army guards rice fields in Viet Nam
- Corn going to bio fuel not food
- Food riots in poorer countries
- World Bank spending money directly on food – no time for economic development

Decreased Water Supply

Melting Glaciers

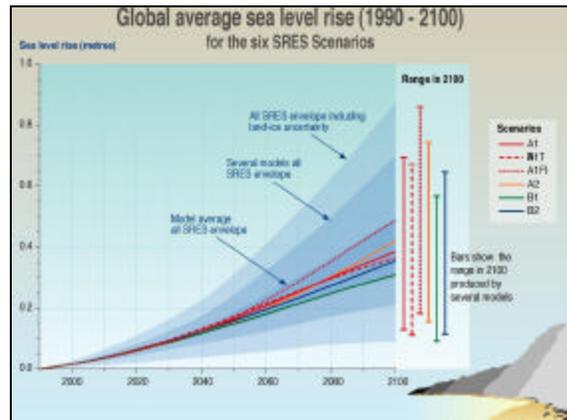
Glacier National Park



1932

1988

Larsen B Ice Shelf - 2002



Sea Level Problems

- Small increase places people around the world in danger from storm surges
- Rise could be several meters if Greenland and Antarctica melt faster than estimated
- Many coastal areas would be flooded

Positive Feedback Loop

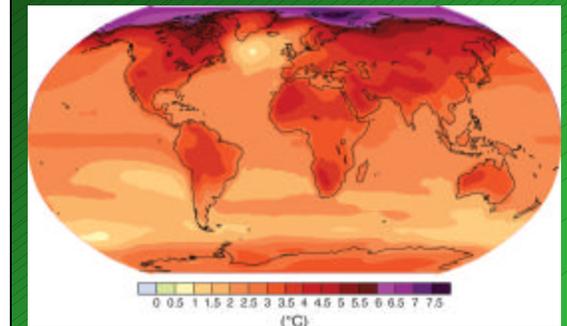
- Warming causes something that causes further warming
- Arctic Melting
- Ice reflects 80% of sunlight
- Water absorbs 80% of sunlight
- Ice melts – water absorbs more sunlight – melts more ice

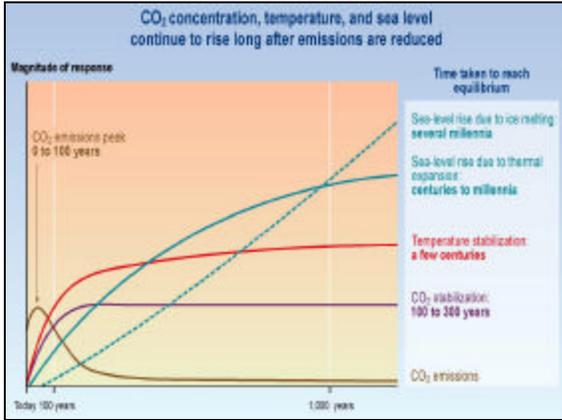
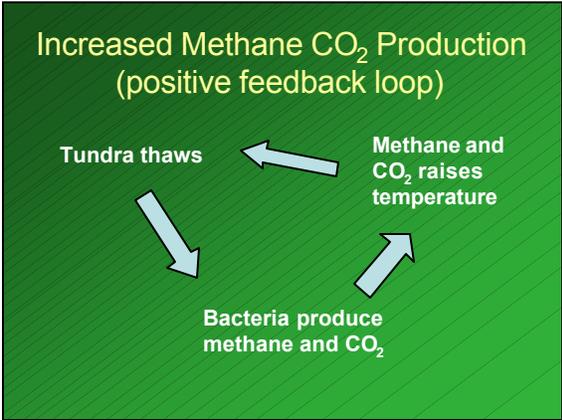


Melting Tundra



A1B – Moderate Scenario

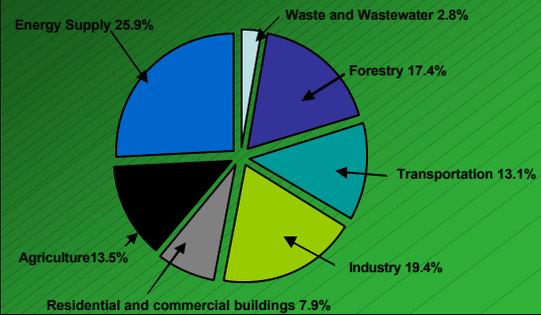




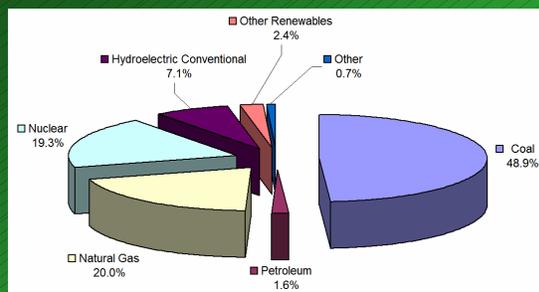
What Can We do?

- Stop using fossil fuels?
- Carbon sequestration?
- Hydrogen?
- Solar Power?
- Wind Power?
- Nuclear Power?
- Geothermal Power?

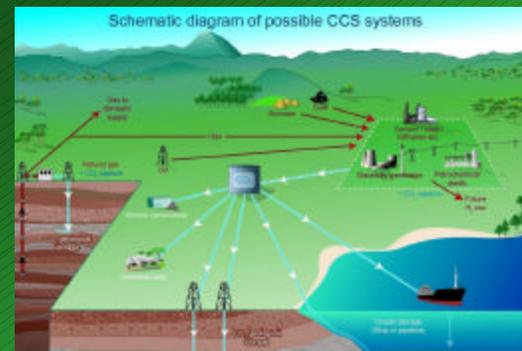
Sources of GHG



Electrical Energy Generation



Carbon Sequestration



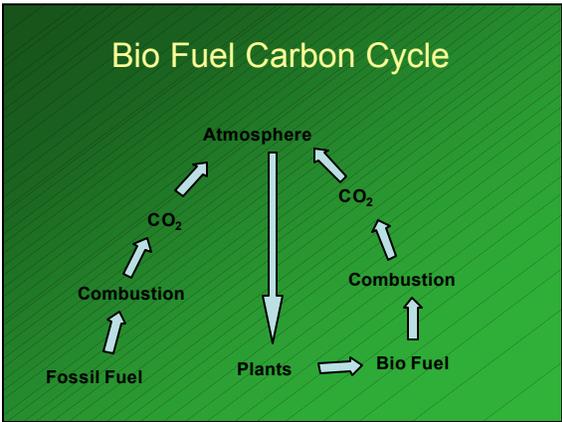
Nuclear Power

- IV Generators much more efficient
- Still produce radioactive waste – where do you put it
- Still produces plutonium – how do you keep it from being used in bombs

Transportation

- Bio Fuels – Do they produce CO₂ also?
- Ethanol – burning in existing engines
- Hydrogen – fuel cell
- Electric – using battery technology

Bio Fuel Carbon Cycle



Ethanol

- Can burn in existing engines
- 34% less energy than gasoline
- Run much higher compression ratios to increase efficiency
- Largely produced by corn in US
- If all corn grown in US were converted to ethanol it would make up 12% of our gasoline needs

More Corn Based Ethanol

- It would take 75% of all cultivated land on the earth to make enough ethanol to replace US gasoline consumption
- It takes 1 unit of fossil fuel to produce 1.3 units of ethanol
- The corn required to produce 25 gallons of ethanol would feed a person for a year.
- New technology using cellulose technology is more efficient

Hydrogen

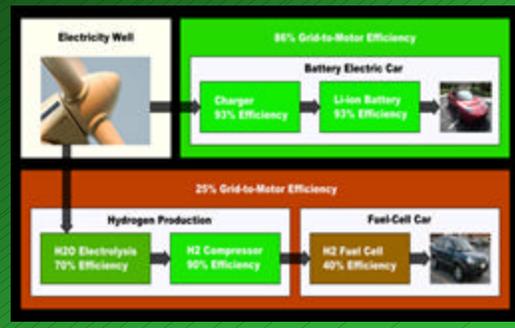
- Where does it come from?
- Can we create it without creating CO₂
- Is waiting for hydrogen technology just another way to stall?



Current Hydrogen Production

- **48% from Natural Gas**
- **30% from oil**
- **18% from coal**
- 4% from electrolysis – poor efficiency
- High temperature electrolysis – 50% more efficient (850 °C – 1000 °C)
- Up to 30% of energy used for compression

Hydrogen Fuel Cell vs. Battery



Your Challenge

- Engineers determine the shape of the future
- You cannot dream your father's dream
 - Different problems
 - Different solutions
- Don't be afraid to see a different future

Questions ???