Topics

- Geothermal Energy
- Hydrogen
- Biofuels
- Wind Power
- Solar Energy
- Hydropower & Ocean Energy
Geothermal Energy

- Heat is generated in the earth's mantle and core via radioactive decay.
- Heat is transferred to water and rock in the earth's crust by mantle convection.
- The hot water is pumped from the ground and used to drive turbines.

http://earthquake.usgs.gov/learn/glossary/?term=oceanic%20spreading%20ridge
Types of Geothermal Plants

http://energy.gov/eere/geothermal/electricity-generation
Advantages and Disadvantages

- Sustainable
- High energy potential
- Very low emissions
- Economically competitive
- Small footprint

- Can quench wells
- High upstart cost
- Limited by location

http://www.energy.ca.gov/tour/geysers/
Hydrogen

- Most abundant element in the universe
- Produced by:
  - steam reforming
  - electrolysis of water
- Can be used as a fuel source or an energy carrier
As a Fuel Source

- Burned to drive mechanical work
- Passed through a fuel cell to generate electricity

http://www.pbs.org/wgbh/nova/sciencenow/3210/01-car-nf.html
https://mix.msfc.nasa.gov/abstracts.php?p=2388
As an Energy Carrier

- Electricity from a primary source is used to electrolyze water
- Hydrogen gas produced can be stored and transported
- Hydrogen gas is passed through a fuel cell when electricity is needed

https://www.fueleconomy.gov/feg/fcv_PEM.shtml
Advantages and Disadvantages

- Near zero emissions
- Abundant

- Hard to store
- Extremely flammable
- Greenness dependent on primary energy source
- Fuel cell cost
- Low density

http://en.wikipedia.org/wiki/Hindenburg_disaster
Biofuels

- Derived from biomass
- Can be directly converted into liquid fuels
- Highly renewable

http://www2.hawaii.edu/~khanal/biofuel/2nd_gen.png
Process

- Harvest
- Enzyme breakdown
- Fermentation
- Separation
- Transportation
- Repeat

http://news.illinois.edu/WebsandThumbs/jin_yong_su/BioenergyChain_b.jpg
Advantages and Disadvantages

- Can reduce carbon dioxide emissions
- Liquid fuel
- Cheap feedstock

- Not as efficient
- Expensive process
- Plant consumption
- Use of fertilizers
- Water use
Wind Power

- Power is derived from airflow using wind turbines
- Wind > Mechanical > Electricity
- Three major types
  - Utility-scale wind
  - Small wind
  - Offshore wind

Turbine - How it works

- Pathway
  - Wind
  - Blades
  - Shaft
  - Gear box
  - Generator

Advantages and Disadvantages

- Clean
- Low maintenance
- Conserves water
- Dependent on wind
- Location limited
- High capital costs
- Noise from turbines

Wind Energy Impact on Avoiding Carbon Dioxide Emissions

Solar Energy

- Light and heat harnessed from the Sun using modern technology
- Clean and extremely abundant
- Two ways of being captured and converted into electricity

Solar Thermal

1. Tube with fluid that absorbs heat
2. Steam
3. Turbine
4. Generator

Solar PV

1. Photovoltaic Cells
2. Electricity

http://epa.gov/climatestudents/solutions/technologies/solar.html
Advantages and Disadvantages

- Indefinitely renewable
- Silent
- Many applications
- Expensive
- Intermittent
- Location

http://energyinformative.org/solar-panels-cost/
Hydropower & Ocean Energy

- Taking energy from water and converting it to power
- Hydro, wave, tidal, and thermal (OTEC)

http://eandemanagement.com/2012/03/ireland-and-the-us-to-co-operate-on-ocean-energy/
Hydropower

- From the energy of moving water
- Nation’s largest source of renewable electricity

http://epa.gov/climatestudents/solutions/technologies/water.html
Wave & Tidal Energy

- Harnesses energy from waves and tides to create power
- Waves power uses a wave energy converter (WEC) as waves rise and fall
- Tidal power uses turbines as tides rush in and out of the coast

http://searaser.net/  
http://technologystudent.com/images5/tidal1.gif
Advantages and Disadvantages

- Green/Clean
- Huge energy potential
- Reliability
- Costs
- Effect on marine life and surrounding environment
- Location

http://inhabitat.com/wave-power-lights-up-u-s-electrical-grid-for-first-time/
Ocean Thermal Energy Conversion

- Harness solar energy absorbed by the ocean
- Open cycle, closed cycle, & hybrid

Advantages
- Uses clean, renewable, natural resources
- Can produce fresh water in addition to electricity
- Reduced dependence on fossil fuels

Disadvantages
- Needs a large difference in temperature
- Transmitting energy big distances
- Present cost

http://astronomy.nmsu.edu/cwc/CWC/LapTop/MyPictures/MillennialProj/
Conclusion

- There is no single solution to the fossil fuel problem.
- A combination of these resources will be needed to meet the world’s energy demands.
- Fossil fuels remain the most economical solution in most cases.

http://www.eia.gov/forecasts/aeo/electricity_generation.cfm
Acknowledgments