APES Chapter 13 – Achieving Energy Sustainability

Intro: Energy from the Moon?

Would / Does tidal power work? How does it work?

In what ways is tidal power an improvement on wind and solar power?

What are the limitations?

I. What is Renewable Energy?

A. Let's start with what it is not:

B. The Renewables include:

Potentially renewable –

Non-depletable –

C. Global Energy Use (fig. 13.2)
87% Nonrenewables

13% Renewables

D. In the U.S. (fig. 13.3)
97% Nonrenewables

7% Renewables

II. How Can We Use Less Energy? Energy Conservation! (see fig. 13.4)

A. As individuals (for personal and/or financial reasons)

B. Gov't programs that encourage conservation

C. Gov't mandates that promote conservation

D. Goal of reducing Peak Demand

1. requires back-up sources

2. build in excess generating capacity

3. dealing with the 2nd Law of Thermodynamics

Note: Conservation and Increasing Energy Efficiency are considered our least expensive and most environmentally sound options for extending energy supply.

E. Sustainable Design (a.k.a. Green Design) Building in energy efficiency (see figs. 13.5 and 13.6)
Design Elements:
1. Passive Solar Design – for heating, cooling, lighting…several elements:

2. Materials with High Thermal Inertia – retain heat and cold temps

3. Use topography/embed in ground, landscaping, green roof

4. Use of recycled and re-purposed materials in construction

(see fig. 13.7)

III. Biomass – a Form of Energy from the Sun

A. Biomass includes:

B. Modern Carbon vs. Fossil Carbon

C. Solid Biomass (wood, charcoal, manure)

Global use =

U.S. use =

1. Wood for wood stoves

2. Charcoal

3. Manure

D. Biofuels
1. Ethanol (see p. 352) US from Corn….Brazil from Sugar Cane

Fuels: E85

Gasohol

2. Biodiesel – substitute for petroleum-based diesel fuel

B 20 = 80% petroleum diesel and 20% biodiesel

SVO = Straight Vegetable Oil…from soybeans, vegetable oil, algae *

IV. Hydropower / Hydroelectric

A. Converts the PE and KE of water to Electrical Energy

About 7% of US electrical generation (mostly in CA, OR, WA)

Globally, China is #1, Brazil #2, then the US

B. Three different hydropower systems:

1. Run of the River

2. Water Impoundment (High Wall Dams)

There are sustainability questions:

3. Tidal Power

V. Capturing Sunlight – The Solar Power Revolution (see fig. 13.15)

A. Passive Solar – limited, but important uses in home/building design

B. Active Solar – using specialized devices to capture and convert solar energy

1. Water Heating systems – using heat exchangers (see fig. 13.17)

2. Photovoltaic (PV) Cell Systems – convert light energy directly to electrical (see fig. 13.18)

3. Concentrating Solar Thermal Electrical Systems (CST)

C. Solar's Advantages:

Solar's Disadvantages:

VI. Geothermal – Using Earth's Heat as a Renewable Resource

A. Direct Geothermal Heat –
   1. use of steam heat for heating systems

   2. use of steam to generate electricity

   Disadvantages of these systems:

B. Ground Source Heat Pump/Heat Exchange (see fig. 13.20)
   1. Heating a building

   2. Cooling a building

VII. Wind Energy – rapidly growing contributor to electricity generation

(see 13.21 wind capacity and % of electricity from wind)

A. Wind turbine – can produce 2-3 MW while turning…power 400 homes. (see fig. 13.22)

B. Offshore Wind Farms (see fig. 13.23) – higher generating capacity
   Proposals for Lake Erie, Cape Cod

VIII. Fuel Cells – (see fig. 13.25)

A. Basic functioning of a fuel cell

   Basic requirement…supply of H gas….from water ….or methane

   Storage: can't store electricity, but we can store H gas until needed!

B. Advantages of Fuel Cells:
   Efficiency of up to 80%

   Can power electric motors in vehicles…much more efficient than gasoline

   Disadvantages:

IX. Planning Our Energy Future – no single source can meet all of our needs…so…

A. Developing New Technology…staying ahead of depletion…extending reserves

Short term:

B. Improve the Grid – improve infrastructure…increase capacity…reduce losses

Develop a Smart Grid (defined as an efficient, self-regulating distribution network, that can accept any source of electricity…provide to end users)

(see fig. 13.26) – Smart House on the Smart Grid
Key is managing energy use with Peak Demand and Peak Loads.

C. Move from Regional Generating Plants to Local "Micro" Generation

D. <u>Electricity Generation Cost</u> (Cost drops as installed capacity grows) and <u>Storage of Energy (how to store electricity)</u> (use excess energy to pump water uphill then release later to turn a turbine)

E. What is our "price point" for engaging in serious conservation/innovation?

Oil	Natural Gas
Gasoline	Electricity

X. Working Toward Sustainability – Alternative Energy in Iceland

What are they doing, and what energy forms are utilized?

Why are they doing this?

What is Hydrogen being used for?

XI. Science Applied: Should Corn Become Fuel

Compare the Inputs to the Outputs (1 : 1.3 ratio)

Consider:

Is Ethanol carbon neutral?

Does the trade off (less oil, more coal) make sense?

Any climate benefit?

Any food benefit? Any food consequences?

Alternatives: produce Cellulosic Ethanol (from timber and farm waste, grasses, algae)