Energy Efficiency & Renewable Energy Resources

tutorial by Sharon Ashworth & Paul Rich
Outline

1. Energy efficiency
2. Solar energy
3. Producing electricity from water
4. Producing electricity from wind
5. Producing energy from biomass
6. The solar–hydrogen revolution
7. A sustainable energy strategy
1. Energy Efficiency

What is it?
the percentage of total energy input that does useful work in an energy conversion system

Fig. 16–3
Energy Efficiency

Net energy efficiency

the net efficiency of the entire energy delivery process is determined by the efficiency of each step in the energy conversion process.

Fig.16–4
Energy Efficiency

Energy waste

43% of the energy used in the U.S. is unnecessarily wasted by using inefficient methods to produce electricity, heat our homes, & drive our cars.

Fig. 16–2
Energy Efficiency

The importance of reducing energy waste

- nonrenewable fuels last longer
- time to phase in renewable energy resources
- decrease dependence on oil imports
- reduce local & global environmental damage
- slow global warming
- save money
Energy Efficiency

Improving energy efficiency

• cogeneration
  the production of two useful forms of energy
  from the same fuel source

• energy conservation & use of energy efficient
  lighting & appliances

• increases in the fuel efficiency of motor
  vehicles or use of alternative fuel vehicles

• better insulated homes
Passive solar heating

- Sunlight is captured directly within a structure & converts it into low-temperature heat for space heating.
- Heat is stored in walls & floors made of materials like concrete, brick, stone, or tires & is released slowly throughout the day.
Solar Energy

Passive solar heating

• A passive solar & superinsulated design is the cheapest way to heat a home in regions where sunlight is available more than 60% of daylight hours.

Fig. 16–15
Active solar heating

- solar collectors absorb solar energy & a fan or pump supplies the building’s space or water heating needs

Fig. 16–12a
Solar Energy

Active & passive solar heating

Pros
• solar energy is free
• net energy yield is high for passive & moderate for active
• technology is well developed & easily installed
• takes up little land space
• does not emit polluting or greenhouse gases

Cons
• need to secure solar rights
• solar collectors are ugly to some people
• active systems are costly

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Solar Energy

Producing electricity

- solar energy can be converted directly into electrical energy by photovoltaic cells
- sunlight striking silicon atoms creates an electrical current
- electrical energy is stored in batteries for use when the sun is not shining

Fig. 16–17a
Solar Energy

Array of Solar Cell Panels on a Roof
Photovoltaic panels

Power lines

Panel wire

To breaker panel (inside house)

Inverter (converts DC to AC)

Battery bank (located in shed outside house, due to explosive nature of battery gases)

Fig. 16–17b
Solar Energy

Generating high temperature heat & electricity

Figs. 16a–16b

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3. Producing electricity from water

- hydroelectric dams
- tides & waves
- ocean thermal energy conversion & solar ponds

(see Fig. 16–18)
## Producing electricity from water

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
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<tbody>
<tr>
<td>• none of the technologies emit greenhouse or polluting gases</td>
<td>• Dams flood upstream habitats &amp; alter downstream habitats</td>
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<tr>
<td>• high net energy yields for dams &amp; moderate yields for solar ponds</td>
<td>• few areas have the right conditions to use tides &amp; waves</td>
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<td>• thermal energy from bodies of water cannot compete economically</td>
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4. Producing electricity from wind

Pros

• unlimited source of energy at favorable sites
• moderate to high net energy yield
• easy to build & expand
• emit no pollutants or greenhouse gases
• land can also be used for agriculture
Producing electricity from wind

Fig. 16–19

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Producing electricity from wind

Cons

• economical only in areas with steady winds
• back–up energy sources are necessary
• mass production takes up a great deal of land space
• noise pollution
• may interfere with migrating birds
5. Producing energy from biomass

Fig. 16–20
Producing energy from biomass

Using wood

**Pros**
- a potentially renewable energy resource
- high net energy yield if burned near source

**Cons**
- currently exploited in nonrenewable & unsustainable ways
- single–species biomass plantations reduce biodiversity
- burning wood produces air pollutants such as particulates

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Producing energy from biomass

Biofuels as alternatives for gasoline

(see Table 16–1, ethanol & methanol)
Producing energy from biomass

Burning wastes

• crop residues & animal manure can be burned or converted into biofuels
  can be efficient if small–scale & local
• urban wastes can be burned in incinerators to produce electricity & heat
  concerns about emissions of toxic gases released from burning of hazardous materials
6. The solar – hydrogen revolution

Fig. 16–21
The solar – hydrogen revolution

The benefit of using hydrogen
• the source of hydrogen, water, is plentiful
• when burned, hydrogen produces no carbon dioxide, but instead water vapor & nitrogen oxides
• using hydrogen for fuel would eliminate most air pollution problems & reduce greenhouse gas emissions

The problem
• hydrogen is really only a way to store energy; requires energy source to split hydrogen from water
• currently nonrenewable energy sources are used to produce hydrogen, negating many benefits
The solar – hydrogen revolution

The solution

• use renewable sources of energy, most notably solar, to produce hydrogen for combustion

• currently it costs more to use solar energy than other energy sources, but could be phased in over time
7. A sustainable energy strategy

(see Fig.16–23)