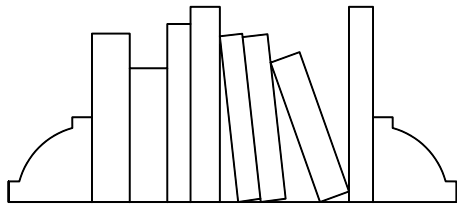


# Energy

## Lecture Outline:

9. RENEWABLE ENERGY RESOURCES  
 – WIND AND SOLAR  
 A. Solar Energy  
 B. Wind Energy



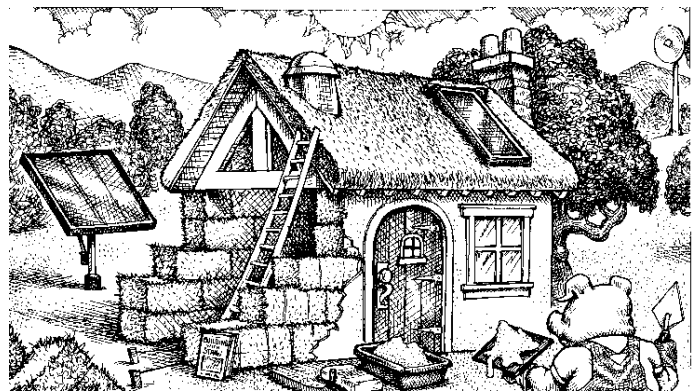
## Learning Objectives:

*When you are finished with this unit you should be able to:*

1. Describe the current state of solar power.
2. List the pros and cons of solar power.
3. Describe the current state of wind power.
4. List the pros and cons of wind power.

## Terms You Should Know:

- ❖ Passive solar system
- ❖ Active solar system
- ❖ Solar cooker
- ❖ Wind energy
- ❖ Solar energy
- ❖ Wind farm
- ❖ Solar farm
- ❖ Photovoltaic cell
- ❖ Parabolic mirror



## Reading Assignment:

Brennan and Withgott:  
 Chapter 21; pages 589-612.

## 9. RENEWABLE ENERGY RESOURCES

### "TURNING TOMORROW INTO TODAY"

#### A. SOLAR ENERGY

- Vast potential as a renewable and sustainable energy source

- Current power costs:

solar— 12¢ per kw

hydropower—

coal utility—

nuclear utility—

Types of systems:

**PASSIVE SOLAR SYSTEM**—captures sunlight directly within a structure and converts into low temperature heat for space heating

**ACTIVE SOLAR SYSTEM**—specially designed collectors absorb solar energy and a fan or a pump is used to supply part of building's space heating or water heating needs

**PHOTOVOLTAIC CELLS (SOLAR CELLS)**—solar energy is directly converted into electrical energy

Parabolic mirrors—are mirrors that focus light from a large area onto a simple, central point

- Focus intense heat on central tube;

—

—

Solar cookers—

Solar box cooker—smaller, insulated box; cooks at 120°C

—

POTENTIAL:

- With an aggressive effort starting now—solar could provide:

2020—

2050—

PROS:

- fuel is free
- only costs are for devices to capture and store energy

–

–

CONS:

- source is intermittent—nights and cloudy days

–

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- unsightliness on houses

The Grand Solar Plan – 2050

- *Scientific American*, January 2008

- With a major effort, in 2050:

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## The Grand Plan Concepts

### 1. Massive Switch

- 
- 
- 

### 2. Vast Area of Photovoltaic Cells

	2007	2050
Land area		
Electricity price		

Where?

### 3. Solar Concentrator Power Plants

4.

5.

### 6. Cost:

\$420,000,000,000 in subsidies  
(similar in cost to farm subsidies)

- 
- 

## The Grand Plan Payoffs

- 
- Global tensions eased and military costs lowered

- Massive trade deficit significantly reduced
- 
- 

US Fuel Consumption:

	2007	2050 (Existing)	2050 (Plan)
Oil (bb)			
Natural Gas (Tcf)			
Coal (b tons)			

## B. WIND ENERGY

- 2% of sun's energy striking the Earth is converted into wind
- Use wind turbines
- Wind power is the world's fastest growing energy source
  -
- China and USA are the world leaders
  - 
  -
- In the USA most wind turbines are in California; however, many have been installed on the Great Plains in the past 6 years

## Total Installed Capacity – 2011

China	62,700 MW
USA	46,900 MW
Germany	29,000 MW
Spain	21,600 MW
India	16,100 MW

## USA

- 100 B kWh – will be generated in 2012
- 
- Texas accounts for about 1/3 of the annual expansion in the USA
- New wind turbine manufacturing facilities in Iowa, Minnesota, and Pennsylvania
- Unlimited resource of energy on favorable sites
- Economical only in areas with steady winds
- With massive adaptation, wind power could provide:
  - 
  -

## Wind Power – World's Electricity

Year	%
1990	
2000	
2011	
2013	
2018	

## Wind – Electricity Penetration – 2011

Country	%
Denmark	
Portugal	
Spain	
Ireland	
Germany	
USA	

## Wind Generation Capacity

2011

2012

2013

Annual growth 2011 – 2014:

Annual growth 2005 – 2010:

### PROS:

- 
- 
- only cost is for devices to capture and store it
- clean, renewable, small land requirement
- technology is well developed
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### CONS:

- wind does not blow all the time
- storage of energy is a weakness

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–  
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### Wind Energy – Increasingly Competitive

- "Large wind" is competitive (4-7¢/kWh)
- 
- Technology is improving
- 

### Wind Energy – Revitalize farms and rural communities

- Single wind turbine can provide \$2,000-\$4,000/year per megawatt in farm income (2% of land)
- 
- 
- Each MW provides 2.5-3 job-years of employment
- 
- Natural gas supplies in North America are being depleted
- Installed capacity at 11,603 MW of wind will save 0.5 billion cubic feet of natural gas/day
- USA currently burns 13B cf/day for electricity; wind reduces NG use for power generation by 5%
- Expanding wind production is a cost-effective way to conserve gas supplies



## Wind Energy – increase security of electricity supply

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- 
- Consists of small (by utility standards) individual generators which can not be easily damaged at the same time
- If wind plant is damaged, there is no secondary threat to the public (release of radioactivity, explosions, breaching of a dam)

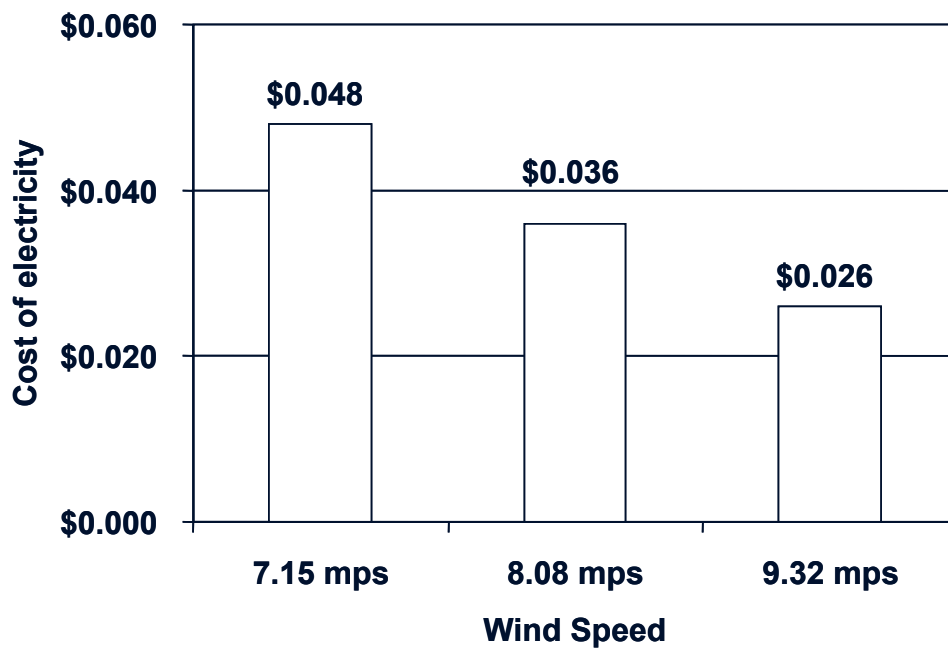
## Wind Energy – Better for the Earth!

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## Wind Energy Potential

1. North Dakota B kWh
2. Texas
3. Kansas
4. South Dakota
5. Montana
6. Idaho

Cost of energy and Wind Speed



Cost of Energy – Large Windfarm v. Small

