

1 ☐ Energy: Renewable Energy

EVPP 111 Lecture

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2 ☐ OUTLINE

- + Renewable vs. non-renewable energy
- + Renewable energy types
- + Energy conservation

3 ☐ Energy: Renewable Energy

- + **Renewable vs. Non-Renewable Energy**
 - + **Renewable energy**
 - + replenish themselves
 - + biomass
 - + continuously present
 - + solar
 - + geothermal
 - + tidal/oceanic
 - + collectively supply ~3% of world's energy
 - + fossil fuels ~ 90%, nuclear ~ 7%

4 ☐ OUTLINE

- + Renewable vs. non-renewable energy
- + Renewable energy types
- + Energy conservation

5 ☐ Energy: Renewable Energy

- + **Renewable energy types**
 - + hydroelectric
 - + tidal/oceanic
 - + geothermal
 - + wind
 - + solar
 - + biomass conversion
 - + waste to energy

6 ☐ Energy: Renewable Energy

- + **Renewable energy types**
 - + hydroelectric
 - + tidal/oceanic
 - + geothermal
 - + wind
 - + solar
 - + biomass conversion
 - + waste to energy

7  **Energy: Renewable Energy**

- + **Renewable energy types**
 - + **hydroelectric**
 - + using flowing water to generate electricity

 - + today, used almost exclusively to generate electricity
 - + in past, used to directly power some machines
 - + grain mills
 - + saw mills
 - + machinery for textile industry

8  **Energy: Renewable Energy**


- + **Renewable energy types**
 - + **hydroelectric**
 - + three ways to produce hydroelectric power
 - + impoundment
 - + diversion
 - + pumped storage

9  **Energy: Renewable Energy**

- + **Renewable energy types**
 - + **hydroelectric**
 - + **impoundment**

 - + **diversion**

 - + **pumped storage**

10  **Fig. 16.11a**

11  **Energy: Renewable Energy**

- + **Renewable energy types**
 - + **hydroelectric power potential**
 - + distributed among continents in rough proportion to
 - + land area

 - + topography


12  **Energy: Renewable Energy**

- + **Renewable energy types**
 - + **hydroelectric power**
 - + supplies ~2.5% of world's commercial energy

- ✦ % electricity generated by hydropower
 - ✦ Norway, ~99%
 - ✦ South America, ~73%
 - ✦ developed world as whole, ~44%

13  Global Per. p. 207a

14 

15  Fig. 10.15b

16  **Energy: Renewable Energy**

- ✦ **Renewable energy types**
 - ✦ **hydroelectric power**
 - ✦ advantages
 - ✦ high efficiency (80%)
 - ✦ low-cost electricity
 - ✦ long life spans for “plants”
 - ✦ very clean
 - ✦ no emissions of CO₂ or other greenhouse gases from operation
 - ✦ may provide flood control below dam
 - ✦ provides water for year-round irrigation in some areas

17  **Energy: Renewable Energy**

- ✦ **Renewable energy types**
 - ✦ **hydroelectric power**
 - ✦ disadvantages
 - ✦ high environmental impacts
 - ✦ floods natural areas
 - ✦ converts terrestrial to aquatic habitats
 - ✦ potential loss of species
 - ✦ reduction in nutrient-rich silt deposition downstream
 - ✦ emission of CO₂ and CH₄ from rotting vegetation trapped in reservoirs

18  **Energy: Renewable Energy**

- ✦ **Renewable energy types**
 - ✦ **hydroelectric power**
 - ✦ disadvantages
 - ✦ high construction costs
 - ✦ danger of collapse
 - ✦ decreases fish harvest below dam
 - ✦ relocates communities
 - ✦ causes loss of fertile agricultural land
 - ✦ submerges cultural resources

19  **Energy: Renewable Energy**

- ✦ **Renewable energy types**
 - ✦ **hydroelectric power**

- ✦ **Three Gorges Dam**
- ✦ across Yangtze River, China

✦ began in 1997, should be complete in 2009

20  **Energy: Renewable Energy**

- ✦ **Renewable energy types**
- ✦ **hydroelectric power**
- ✦ **Three Gorges Dam**
 - ✦ largest dam in world
 - ✦ 1.3 miles wide, 610 feet tall
 - ✦ cost ~\$40 billion
 - ✦ reasons for dam
 - ✦ electricity
 - ✦ transform upper Yangtze into more navigable, economic waterway
 - ✦ provide flood control to middle and lower reaches of river (prone to frequent, disastrous floods)

21  **Energy: Renewable Energy**

- ✦ **Renewable energy types**
- ✦ **hydroelectric power**
- ✦ **Three Gorges Dam**
 - ✦ projected consequences of dam
 - ✦ threaten migratory fish
 - ✦ concentrate water pollution
 - ✦ endanger to point of extinction: Chinese alligator, river dolphins, Siberian white crane, Chinese sturgeon
 - ✦ inundate 153 towns, 4500 villages, necessitating relocation of people
 - ✦ submerge archeological sites, scenic canyons

22 

23  **Energy: Renewable Energy**

- ✦ **Renewable energy types**
- ✦ hydroelectric
- ✦ tidal/oceanic
- ✦ geothermal
- ✦ wind
- ✦ solar
- ✦ biomass conversion
- ✦ waste to energy

24  **Energy: Renewable Energy**

- ✦ **Renewable energy types**
- ✦ **tidal/oceanic**

- + employs same principle as hydroelectric plant

25  **Energy: Renewable Energy**

- + **Renewable energy types**
 - + **tidal/oceanic**
 - + problems
 - + obstruction of
 - + fish migration
 - + silt transport
 - + water flow
 - + concentration of pollutants

26  **Energy: Renewable Energy**

- + **Renewable energy types**
 - + **tidal/oceanic**
 - + facilities are rare
 - + Rance River Estuary, Brittany coast, France
 - + Nova Scotia. Canada

27 

28  **Energy: Renewable Energy**

- + **Renewable energy types**
 - + hydroelectric
 - + tidal/oceanic
 - + geothermal
 - + wind
 - + solar
 - + biomass conversion
 - + waste to energy

29  **Energy: Renewable Energy**

- + **Renewable energy types**
 - + **geothermal**

- ✦ earth's core temps ~ 4,400 °C
- ✦ in some areas, molten material is close enough to surface to heat underground water and form steam
 - ✦ used to generate electricity
- ✦ alternative energy source rather than true renewable energy source
 - ✦ heat can be withdrawn faster than it can be replenished

30 **Energy: Renewable Energy**

- ✦ **Renewable energy types**
 - ✦ **geothermal**
 - ✦ use
 - ✦ US has ~50% of world's geothermal electrical generating power
 - ✦ California alone produces ~40% of world's geothermal electricity
 - ✦ Pacific Gas & Electric has one of world's largest of geothermal generating facilities, north of San Francisco, serves ~2.9 million people
 - ✦ Iceland
 - ✦ ~all buildings of Reykjavik are heated with geothermal energy

31 **Energy: Renewable Energy**

- ✦ **Renewable energy types**
 - ✦ **geothermal**
 - ✦ consequences
 - ✦ steam contains hydrogen sulfide gas
 - ✦ can contribute to air pollution
 - ✦ produces unpleasant odor
 - ✦ minerals in steam
 - ✦ corrode pipes
 - ✦ toxic to fish

32 

33 **Energy: Renewable Energy**

- ✦ **Renewable energy types**
 - ✦ **geothermal**
 - ✦ heat mining

- + uses parallel wells
- + water is pumped from surface, under pressure down one well
- + "hot rocks" heat water as it percolates through rock fissures
- + adjacent well recaptures hot water and returns it to surface
- + steam from hot water generates electricity

34  **Energy: Renewable Energy**

- + **Renewable energy types**
 - + **geothermal**
 - + **heat mining**
 - + Hot Dry Rock Project, Los Alamos, NM
 - + temperature at well bottom is ~240°C (~430°F)
 - + research indicates sufficient useful heat in dry rocks beneath US to generate 6000 times the energy used in US in one year

35 

36  **Energy: Renewable Energy**

- + **Renewable energy types**
 - + hydroelectric
 - + tidal/oceanic
 - + geothermal
 - + wind
 - + solar
 - + biomass conversion
 - + waste to energy

37  **Energy: Renewable Energy**

- + **Renewable energy types**
 - + **wind**
 - + takes advantage of flowing air
 - + fastest-growing new source of electricity since 1998
 - + increasing ~30% per year
 - + some regions better suited to than others
 - + open areas better than wooded

38 ☐ **Energy: Renewable Energy**

+ Renewable energy types

+ wind

- + usually used in conjunction with other sources of electricity that can take over when wind doesn't blow
- + advantages
 - + high efficiency
 - + moderate capital cost
 - + low electricity cost
 - + very low environmental impact
 - + no CO₂ emissions
 - + quick construction
 - + easily expanded

39 ☐ **Energy: Renewable Energy**

+ Renewable energy types

+ wind

- + disadvantages
 - + blades make noise
 - + blades hazardous to birds
 - + visual pollution
 - + requires a lot of land
 - + needs steady winds, backup for when winds don't blow

40 ☐ **Energy: Renewable Energy**

+ Renewable energy types

- + hydroelectric
- + tidal/oceanic
- + geothermal
- + wind
- + solar
- + biomass conversion
- + waste to energy

41 ☐ **Energy: Renewable Energy**

+ Renewable energy types

+ solar

- + sun provides continuous supply of energy that far exceeds world's demands
- + main problems
 - + intermittent in nature
 - + varies within day, across year, by location
 - + all systems that use solar energy must store energy or use alternative sources when sun is not available
 - + diffuse energy source

42 

43  **Energy: Renewable Energy**

- + Renewable energy types
 - + solar
 - + utilized in three ways
 - + **passive heating**
 - + **active heating**
 - + **solar-generated electricity**

44  **Energy: Renewable Energy**

- + Renewable energy types
 - + solar
 - + **passive heating**
 - + sun's energy is converted directly to heat energy when it is absorbed by a surface
 - + based on design, construction materials
 - + energy is "captured" and used on site
 - + no moving parts, system is maintenance free
 - + no energy is used to transfer heat within system
 - + no operating costs
 - + practical only in new construction

45  **Energy: Renewable Energy**

- + Renewable energy types
 - + solar
 - + **passive heating**
 - + design
 - + large window through which sunlight can enter in winter, not directly during summer
 - + large mass upon which sunlight impinges that collects and stores the heat
 - + heat re-radiating from storage mass warms air

46 

47 

48  **Energy: Renewable Energy**

- + Renewable energy types
 - + solar
 - + **active heating**
 - + sun's energy is converted into heat, but transported elsewhere to be used
 - + requires
 - + solar collector
 - + pump
 - + system of pipes
 - + operation and maintenance costs

49  **Energy: Renewable Energy**

- + Renewable energy types

- + **solar**
 - + **active heating**
 - + solar collector transfers sun's energy to liquid-filled tubes
 - + tubes carry warm liquid to area to be heated
 - + heat from liquid-filled tubes is transferred to area to be heated (or transferred to water that needs to be heated)
 - + heat-depleted liquid in liquid-filled tubes is re-circulated to solar collectors

50 

51 

52 

53  **Energy: Renewable Energy**

- + **Renewable energy types**
 - + **solar**
 - + **solar-generated electricity**
 - + process of converting solar energy directly into electrical energy by use of
 - + **photovoltaic (PV) cell**

54  **Energy: Renewable Energy**

- + **Renewable energy types**
 - + **solar**
 - + **solar-generated electricity**
 - + **photovoltaic (PV) cell**
 - + transparent wafer containing a semiconductor material
 - + sunlight energizes electrons, causing them to flow, creating electrical current
 - + produces only tiny amount of electricity

55  **Energy: Renewable Energy**

- + **Renewable energy types**
 - + **solar**
 - + **solar-generated electricity**
 - + **photovoltaic (PV) cell**
 - + many must be wired together in modular panels to produce significant amount of electricity

56  **Energy: Renewable Energy**

- + **Renewable energy types**
 - + **solar**
 - + **solar-generated electricity**
 - + **photovoltaic (PV) cell uses**
 - + solar calculators
 - + road signs
 - + radios
 - + roofs

- ✦ window, under development
- ✦ large arrays can power small communities

57 

58  **Energy: Renewable Energy**

- ✦ **Renewable energy types**
 - ✦ hydroelectric
 - ✦ tidal/oceanic
 - ✦ geothermal
 - ✦ wind
 - ✦ solar
 - ✦ biomass conversion
 - ✦ waste to energy

59  **Energy: Renewable Energy**

- ✦ **Renewable energy types**
 - ✦ **solar**
 - ✦ **biomass conversion**
 - ✦ **biomass**
 - ✦ any accumulation of organic material produced by living organisms
 - ✦ **biomass conversion**
 - ✦ process of obtaining energy from chemical energy stored in biomass

60  **Energy: Renewable Energy**

- ✦ **Renewable energy types**
 - ✦ **solar**
 - ✦ **biomass conversion**
 - ✦ biomass can be
 - ✦ burned directly as source of heat or for cooking
 - ✦ burned to produce electricity
 - ✦ converted to alcohol
 - ✦ used to generate methane

61 

62  **Energy: Renewable Energy**

- ✦ **Renewable energy types**
 - ✦ hydroelectric
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 - ✦ geothermal
 - ✦ wind
 - ✦ solar
 - ✦ biomass conversion
 - ✦ waste to energy

63  **Energy: Renewable Energy**

- + **Renewable energy types**
 - + **waste to energy**
 - + use of municipal waste as source of energy
 - + requirements
 - + sorting waste
 - + securing sufficient quantity and steady supply

64  **Energy: Renewable Energy**

- + **Renewable energy types**
 - + **waste to energy**
 - + concerns
 - + air pollution
 - + formation of toxic compounds such as dioxins

65 

66  **OUTLINE**

- + Renewable vs. non-renewable energy
- + Renewable energy types
- + Energy conservation

67  **Energy: Renewable Energy**

- + **Energy conservation**
 - + important part of strategy for meeting energy needs
 - + ~84% of all commercial energy in US is wasted
 - + 41% wasted automatically
 - + 43% wasted unnecessarily
 - + using fuel-wasting vehicles, furnaces, devices
 - + living in leaky, poorly-insulated, poorly designed buildings


68  **Energy: Renewable Energy**


- + **Energy conservation**
 - + three least energy-efficient devices in widespread use today
 - + incandescent light bulb
 - + wastes ~95% of energy input
 - + vehicles with internal combustion engines
 - + waste ~86-90% of energy in their fuel
 - + nuclear power plants producing electricity for space heating or water heating
 - + wastes ~86% of energy in their nuclear fuel (92% when energy associated with dealing with radioactive wastes is included)

69  **Energy: Renewable Energy**

- + **Energy conservation**
 - + in homes/buildings
 - + insulate thoroughly
 - + eliminate leaks
 - + replace incandescent with fluorescent bulbs

- + same amount of light for 25% of the energy
- + use energy-efficient appliances
- + use low-emissive glass
 - + reduce amount of heat entering building while allowing light to enter
- + automatic timing devices for heating, lighting, air conditioning

70  Fig. 10.27a

71  Fig. 10.27c

72 

73  The End