

1 ☐ Energy - Patterns of Consumption

EVPP 111 Lecture

Dr. Kim Lergen

2 ☐ OUTLINE

- ✦ **History of Energy Consumption**
- ✦ **Energy Consumption Trends**
- ✦ **Energy and Economics**
- ✦ **Types of energy**
- ✦ **Fossil Fuels - Industrial Revolution**
- ✦ **Automobiles and Energy**
- ✦ **Electrical Energy**

3 ☐ History of Energy Consumption

- ✦ Energy is essential to maintain life
 - ✦ every form of life and every society
 - ✦ requires a constant input of energy

4 ☐ History of Energy Consumption

- ✦ **Biological energy sources**
 - ✦ in nearly every ecosystem
 - ✦ sun provides constant source of energy
 - ✦ initial transfer of energy from sun
 - ✦ occurs via photosynthesis
 - ✦ primitive humans
 - ✦ had nearly all of their energy requirements met by their food
 - ✦ they were not really any different from other animals in their ecosystems

5 ☐ History of Energy Consumption

- ✦ **Very early in human history**
 - ✦ humans began to exploit additional energy sources to make life more comfortable
 - ✦ domesticating plants and animals
 - ✦ as sources of
 - ✦ food
 - ✦ as well as energy for transportation, farming, other tasks

6 ☐ History of Energy Consumption

- ✦ **Increased use of wood**
 - ✦ early civilization such as Aztecs, Greeks, Egyptians, Romans, Chinese
 - ✦ were culturally advanced
 - ✦ relied on sources of energy such as
 - ✦ human muscle, animals muscle

- ✦ (with exception of some wind and water powered devices such as ships and canoes)

7 History of Energy Consumption

✦ Increased use of wood

- ✦ early civilization's first use of energy in a form other than food was
 - ✦ controlled use of fire through burning of wood
 - ✦ provided a source of fuel for
 - ✦ heating and cooking
- ✦ eventually, this "biomass" energy was used in simple technologies
 - ✦ such as shaping tools and extracting metals

8 History of Energy Consumption

✦ Increased use of wood

- ✦ when dense, rapidly growing human settlements
 - ✦ quickly outstripped wood production,
 - ✦ wood had to be imported, or
 - ✦ alternative fuel sources had to be sought

9 History of Energy Consumption

✦ Increased use of wood

- ✦ some areas of world experienced wood shortage hundreds of years before Europe and North America did
 - ✦ due to longer history of higher population densities
 - ✦ animal dung replaced wood as fuel source in some of these areas
- ✦ Europe's forests supplied adequate wood fuel until about 13th century
- ✦ North America's forests supplied adequate wood fuel until late 19th century

10 History of Energy Consumption

✦ Increased use of wood

- ✦ when local supplies of wood declined in Europe and North America
 - ✦ coal was available as alternative energy source
 - ✦ by 1880, coal had replaced wood as primary energy source

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12 Fossil Fuels & The Emerging Industrial Revolution

- ✦ During Carboniferous period, (275-350 MYA)
 - ✦ conditions were right for build-up of large deposits **fossil fuels**
 - ✦ remains of plants, animals, and microorganisms that lived millions of years ago
- ✦ first fossil fuel to be used extensively was coal
 - ✦ at beginning of industrial revolution

13 Fossil Fuels & The Emerging Industrial Revolution

✦ Industrial Revolution

- ✦ began in early 18th century in England
 - ✦ then spread to Europe and North America

- ✦ major cultural change that involved invention of
 - ✦ machines that replaced human & animal labor in manufacturing & transporting goods
 - ✦ central to this transformation was steam engine
 - ✦ capable of converting heat energy into forward motion

14 **Fossil Fuels & The Emerging Industrial Revolution**

✦ **Industrial Revolution**

- ✦ fuel for these machines was first wood,
 - ✦ which was quickly replaced by coal.
 - ✦ countries or regions without large coal deposits were consequently left behind in Industrial Revolution.

15 **Fig. 9.4**

16 **Fossil Fuels & The Emerging Industrial Revolution**

✦ **Industrial Revolution**

- ✦ because expanding factories needed larger labor pools
 - ✦ people began congregating around factories and cities
 - ✦ widespread use of coal in cities led to increased levels of air pollution

17 **Fossil Fuels & The Emerging Industrial Revolution**

✦ **Industrial Revolution**

- energy consumption increased, economies grew, people prospered
- within a span of 200 years,
 - daily per capita energy consumption of industrialized nations increased eight fold.

18 **Energy and Economics**

- ✦ Industrial societies need to ensure a continuous supply of affordable energy
 - ✦ the higher the price of energy
 - ✦ the more expensive goods and services become
- ✦ To keep energy prices down, many countries subsidize their energy industries
 - thus maintaining energy prices artificially low
 - low priced fuels encourage rates of consumption

19 **Energy and Economics**

- ✦ Economic growth and energy consumption
 - ✦ direct link between economic growth and availability of inexpensive energy
 - ✦ economic growth of US was boosted after WW II (which helped end economic depression of the 1930's)
 - ✦ via high employment, rapidly expanding population, good supply of inexpensive energy
 - ✦ resulted in an ever-increasing amount and array of consumer goods
 - ✦ including **automobile**

20 **Energy and Economics**

- ✦ Economic growth and energy consumption
 - ✦ automobiles created a vicious cycle
 - ✦ cars altered people's lifestyles
 - increased travel / tourism
 - requiring more gasoline
 - increased distance from work
 - requiring more gasoline

- ↳ bringing about need for/use of more home labor-saving (energy consuming) devices
 - ↳ 11% electrical energy in US is used to run home appliances

21 Energy and Economics

- ✦ Economic growth and energy consumption
 - ✦ country with high gross domestic product (GDP) uses large amount of energy
 - ✦ as countries industrialize, their energy consumption increases

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23 How Energy is Used

- ✦ Amount of energy used by countries of world varies widely
 - ✦ highly industrialized countries use most of world's energy
 - ✦ less developed countries use less

24 How Energy is Used

- ✦ Countries also use energy in different ways
 - ✦ industrialized nations use energy about equally for:
 - ↳ residential / commercial uses
 - ↳ industrial uses
 - ↳ transportation
 - ✦ less developed countries use energy
 - ✦ mostly for residential purposes
 - ✦ relatively little for industrial purposes

25 How Energy is Used

- ✦ Countries also use energy in different ways
 - ✦ industrialized nations
 - ✦ make up less than 1/5 of world's population but
 - ✦ consume more than 2/3 of the commercial energy supply
 - ✦ US and Canada
 - ✦ make up 5% of world's population
 - ✦ consume about 25% of available energy

26 Table 9.1


27 How Energy is Used

- ✦ How much energy do you use in a year?
 - ✦ In US and Canada
 - ✦ each person uses on average about 300 GJ (equivalent to ~60 barrels of oil) per year
 - ✦ in poorest countries of world, such as Ethiopia, Kampuchea, Nepal, Bhutan
 - ✦ each person uses on average about 1 GJ (~2/10 of a barrel) per year
 - ✦ one person in US consumes, on average, per day almost as much energy as a person in one of poorer countries uses per year

28 Figure 10.1: Annual per capita commercial energy consumption, Raven & Berg

29 How Energy is Used

- ✦ In US
 - ✦ energy use
 - ✦ ~42% for industry
 - ✦ ~33% for residential and commercial buildings
 - ✦ ~25% for transportation

30  Figure 10.2: Energy consumption in the U.S., Raven & Berg

31  **How Energy is Used**

- + Industrial uses
 - + non-industrial countries
 - + use little energy for industry
 - + industrialized countries
 - + use large portion of their energy for industry
- + amount of energy required depends on
 - + types of industrial processes used
 - + efficiency of processes

32  **How Energy is Used**

- + Transportation uses
 - + less-developed countries
 - + use little energy for transportation
 - + highly developed countries
 - + have highest per capita use of energy for transportation

33  **How Energy is Used**

- + Transportation uses
 - + transportation "mix" in a country affects its energy use for transportation
 - + automobiles require about 4 times more energy per passenger kilometer than bus or rail transportation
 - + private automobiles in North America consume over 15% of world's oil production
 - + all other automobiles in world consume 7 %

34  **How Energy is Used**

- + Transportation uses
 - + mass transit systems
 - + most efficient in countries with dense population
 - + most of these countries heavily tax fuel, increasing appeal of mass transit
 - + U.S. policy has kept energy costs low,
 - + thus supporting automobile industry

35  **How Energy is Used**

- + Residential and commercial uses
 - + developed nations
 - + use smaller percentage of energy
 - + less developed nations
 - + use higher percentage of energy

36  **How Energy is Used**

- + Residential and commercial uses
 - + example
 - + ~30% of energy in North America
 - + ~75% of that for air conditioning, refrigeration, water heating, space heating
 - + ~13% of available electrical power in US currently consumed by computers, Internet
 - + up from ~1% in ~1996
 - + ~90% of energy in India

- ✦ ~100% of that is used for cooking

37 **How Energy is Used**

- ✦ Residential and commercial uses
 - ✦ current use patterns determine which conservation methods would be effective
 - ✦ Canada
 - ✦ cold climate
 - ✦ ~40% of energy is used for heating
 - ✦ proper conservation could reduce use by ~50%
 - ✦ Africa
 - ✦ ~50% of energy is used for cooking
 - ✦ fuel-efficient stoves instead of open fires could reduce these requirements by ~50%

38 **Figure 10.2: Energy consumption in the U.S., Raven & Berg**

39 **How Energy is Used**

- ✦ Electrical energy
 - ✦ accounts for large proportion of energy consumed in most countries
 - ✦ electricity
 - ✦ a way energy is consumed
 - ✦ a way energy is supplied
 - ✦ most is produced by burning fossil fuels
 - ✦ major world energy source because
 - ✦ its easily transported
 - ✦ its uses are so varied

40 **How Energy is Used**

- ✦ Electrical energy
 - ✦ consumption varies throughout world
 - ✦ all less-developed nations of world combined
 - ✦ have ~80% of world's population
 - ✦ consume less electricity than US alone

41 **How Energy is Used**

- ✦ Electrical energy
 - ✦ average per capita use of electricity in North America is
 - ✦ 25 times greater than average per capita use in less developed countries
 - ✦ 270 times greater than average per capita use in Nepal
 - ✦ where annual per capita use of electricity is ~23 KWH (enough to light a 100-watt bulb for 1 week)

42 **Energy Consumption Trends**

- ✦ World energy consumption
 - ✦ between 1985 and 2001
 - ✦ increased 19% to total of ~26 million metric tons of oil equivalent per day
 - ✦ conventional fossil fuels accounted ~90% of that total

43 **Energy Consumption Trends**

- ✦ >50% of world energy consumption
 - ✦ results from 25 member countries of Organization for Economic Co-Operation and

Development. (OECD)

- ✦ US, Canada, Australia, New Zealand, Japan, Mexico, countries of Europe

44 ☐ **Energy Consumption Trends**

- ✦ World's major sources of energy
 - ✦ Oil ~40%
 - ✦ Coal ~24%
 - ✦ Natural Gas ~27%
 - ✦ Alternative ~ 9%

45 ☐ Figure 10.9: World commercial energy sources, 1997, Raven & Berg

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47 ☐ **Energy Consumption Trends**

- ✦ Worldwide consumption trends between 1973 and 2000
 - ✦ natural gas: 100% increase
 - ✦ coal: 40% increase
 - ✦ oil: 30% increase

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51 ☐ **Energy Consumption Trends**

- ✦ Primary factors determining energy use:
 - ✦ Political stability
 - ✦ Price of oil
- ✦ During 1980's
 - ✦ energy costs in N. America and Europe declined
 - ✦ thus people became less concerned about energy consumption.
 - ✦ 1979 - oil = \$40 / barrel
 - ✦ 1998 - oil < \$15 / barrel

52 ☐ **SUMMARY**

- ✦ A direct correlation exists between amount of energy used and complexity of civilizations.
- ✦ Wood furnished most early energy.
- ✦ Due to wood shortages, fossil fuels became primary source of energy.
- ✦ Fossil fuel consumption and labor-saving machines, resulted in the Industrial Revolution
- ✦ Because of financial, political, other factors, nations vary in amount of energy they use as well as how they use it..

53 ☐ **The End**