CH1002 Energy Management in Chemical Industries

History of Energy

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Introduction

- Energy is the key “to the advance of civilization”.
- For tens of thousands of years, people relied solely on the chemical (caloric) energy gained from food that produced the mechanical (kinetic) energy of working muscles.
- Most of the family structures, societal groupings, and political and economic institutions created over thousands of years focused primarily on the extraction, processing, exchange, and marketing of food, as well as of "fossil and organic energy sources (wood, peat, coal) ... used ... for heating, cooking, lighting, or for firing the kilns and furnaces used in smelting ores
- Before the modern era, people relied for power on their own muscles, on the muscles of domesticated animals, such as horses and oxen, and on water and wind

Energy Timeline

- Energy before humans
  5,000,000,000 BC

- Beginnings of human energy use
  500,000 BC

- Modern energy by humans
  1850 AD

Energy before humans

- The Sun begins Fusion (c. 5,000,000,000 BC)
- Wind blows on Earth (c. 4,650,000,000 BC)
- Ocean Currents Flow (c. 4,650,000,000 BC)
- Photosynthesis Begins (c. 4,300,000,000 BC)
- Respiration Begins (c. 4,000,000,000 BC)
- Coal, Oil, and Natural gas deposits develop (c. 4,000,000,000 BC)

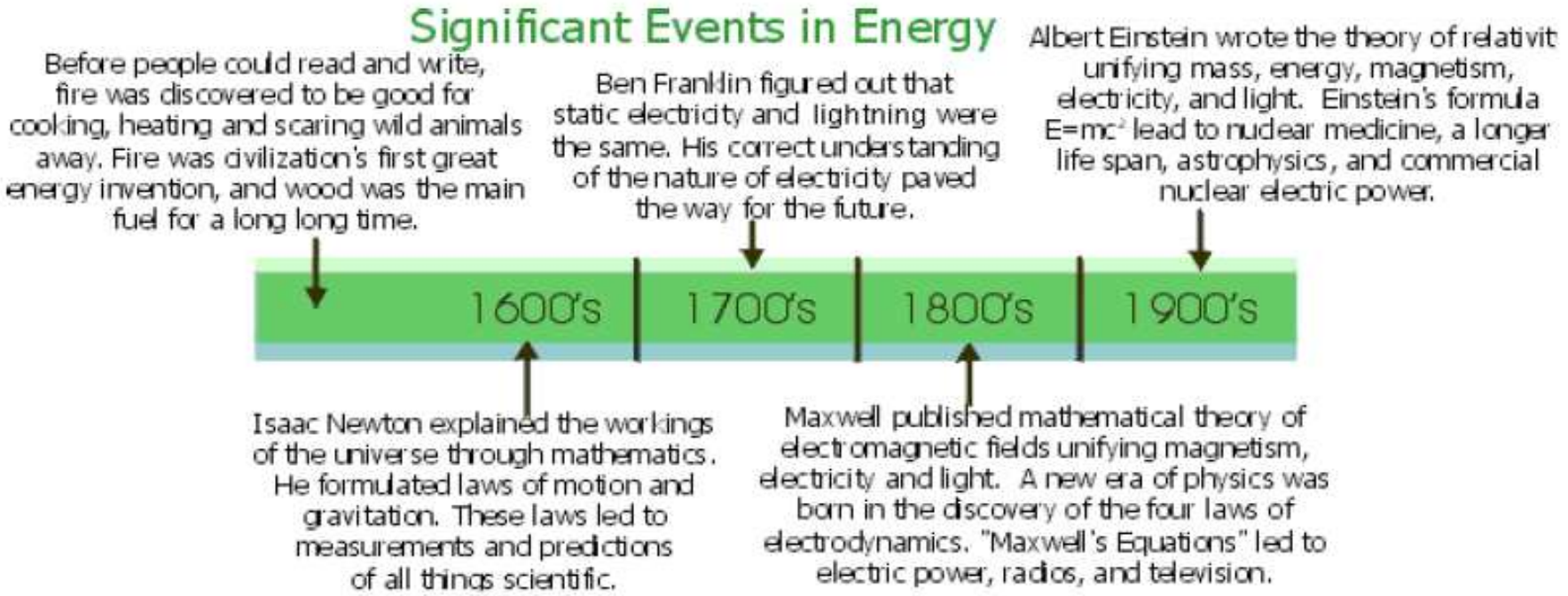
Beginnings of Human Energy Use

- Fire Discovered (c. 500,000 BC) – the turning point in the history of mankind. Controlling their environment, heat and cook food
- Simple machines Utilized (c. 3,500 BC) – wheel, pulleys and levers
- Water and Advanced Wind Power used by Humans (c. 500 BC) - to sail boats in the ocean and in lakes, to separate chaff from rice and grain
- Coal is burnt (c. 100 AD)

Modern Energy by Humans

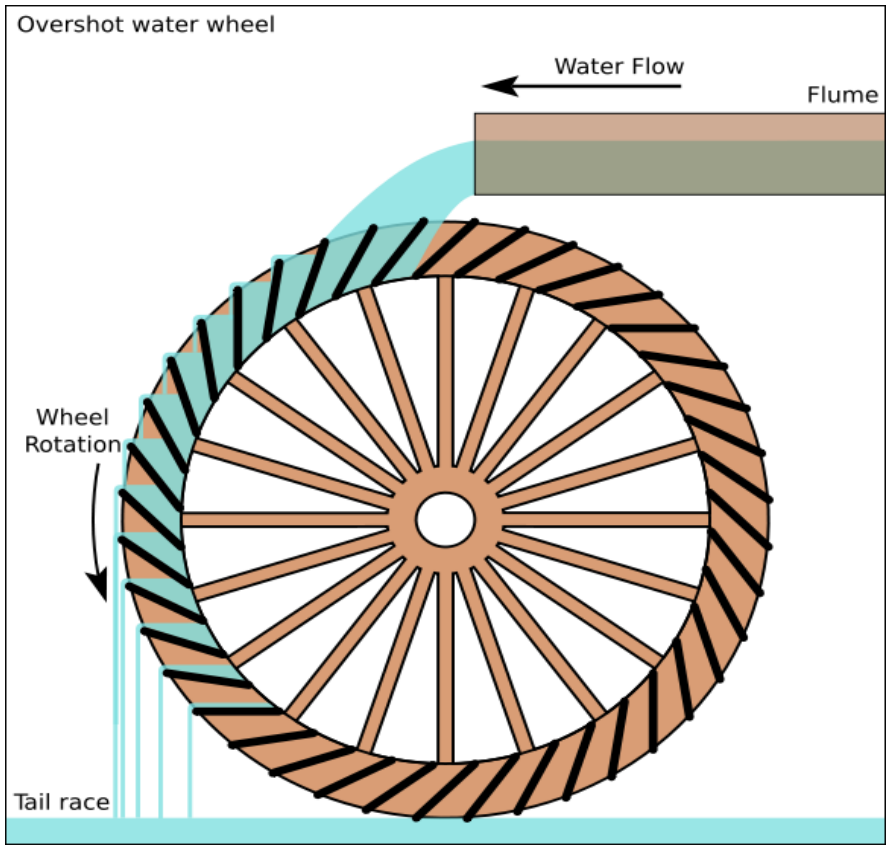
- Coal Powers Trains (1850 AD)
- Coal and Oil - Power Plants Utilized (1875 AD)
- Nuclear Power Discovered (1930 AD)
- Solar Power Used (1970 AD)
- Natural Gas use Widespread (1990 AD)

Energy Timeline



Water Wheel

- Invented two centuries before the time of Christ
- Waterwheels powered mills to crush grain, tan leather, smelt and shape iron, saw wood, and carry out a variety of other early industrial processes.
- Productivity increased, dependence on human and animal muscle power gradually declined, and locations with good water-power resources became centers of economic and industrial activity.



Water Power, Wind Power

- Hydropower evolved from water wheels
- The development of the camshaft and crankshaft allowed water power to be applied to tasks that required a reciprocating motion (e.g., operating trip hammers and blast furnace bellows), which revolutionized the iron industry.
- Meanwhile, the harnessing of wind power to propel sailing ships across wide ocean expanses opened up the Americas to Europe.
- Wind was the first energy source used for transportation

Age of Steam

- The beginning of modern era. 18th century – introduction of steam power
- Entrepreneurs found that steam power overcame water power's geographic inflexibility, the limitation that any one stream could only support a limited number of mills, and waterwheel stoppages and slow downs caused by drought, flooding, and ice.
- The steam engine permanently established the link between fossil energy resources and industrialization
- The scarcity and high cost of good coal on the Pacific Coast combined with discoveries of petroleum in southern California resulted in the development of oil as steam fuel, which unseated coal as steam fuel during the first half of the twentieth century

Electrical Age

- Toward the end of the eighteenth century, fascination with the phenomenon of electricity captured many people
- The production of electricity with primary batteries and eventually with electromagnetic induction, the transmission of electricity through copper wires, and the development of electric motors ultimately revolutionized the transmission of power
- The shape and character of factories changed dramatically during the twentieth century, as machines powered by electric motors could be sited almost anywhere
- Additionally, electric power supplanted horse-drawn and steam-powered street railways with the electric "trolley," it replaced gas for outdoor lighting, and it replaced kerosene lights and wood and coal stoves and heaters in homes

Developments leading to Nuclear Age

- As electricity use became ubiquitous during the twentieth century, the exploitation of energy resources increased enormously.
- Hydroelectricity continued to play an important role in the modern energy matrix, but accessible water power sites were soon tapped.
- Engineers steadily improved steam-turbine technology so that more electricity could be generated by smaller quantities of fuel.
- As the size and efficiency of power plants increased, the cost of electric power dropped dramatically, which stimulated even more consumption of electricity.
- Fossil fuels—first coal, then oil—became the essential energy resources for electric-power generation.
- A growing environmental movement attributed negative environmental impacts to the heavy use of fossil fuels. A search for an alternative to fossil-fuel electric-power generation led many people to the atom.

Nuclear Age (contd.)

- In the wake of World War II, the United States created an Atomic Energy Commission (AEC) to oversee nuclear weapons development as well as to bring nuclear power to peaceful applications.

- During the 1950s, the AEC worked with public utilities such as Pacific Gas and Electric Company in California to develop electric power generation using nuclear fission.

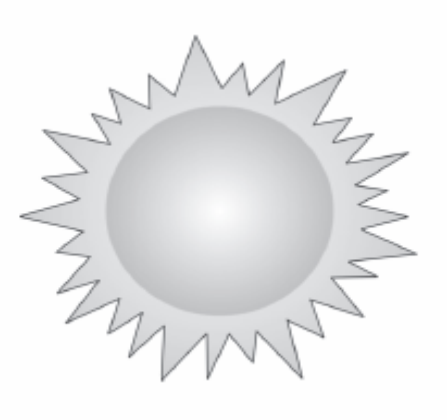
- Industrialized nations everywhere constructed plants to meet ever-multiplying demands for electric power, but nuclear power was not without its drawbacks.

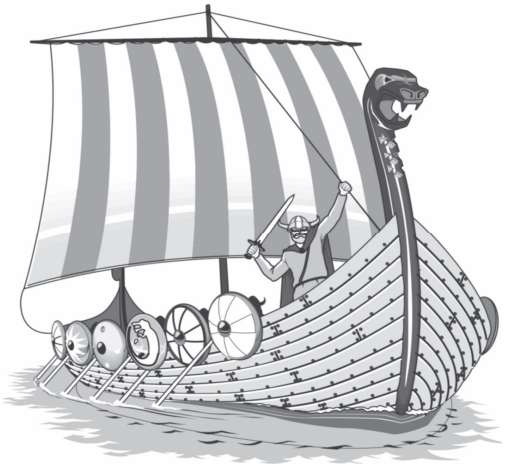
Nuclear Age (contd.)

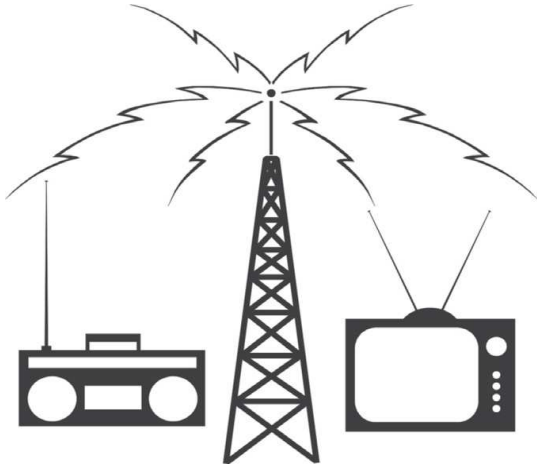
- But by the end of the 1970s, seismic safety became a substantial enough issue for Californians that a moratorium was placed on building new nuclear power plants and the 1979 Three Mile Island nuclear plant accident in Pennsylvania galvanized nuclear power opponents.

- In 1986 the meltdown at the Chernobyl nuclear power plant in the Ukraine and subsequent widespread radiation poisoning, put Italy, Germany, and other countries on the path toward ending reliance on nuclear power

- While nuclear energy has not gone away and is still seen by many people as one of the best solutions to human energy needs, other energy resources such as solar, wind, and biomass also offer promise.







Developments

- The first natural gas well - 1821
- The first oil well - 1859
- The first gasoline car - 1892
- The first power plant - 1882, to send electricity to 85 buildings
- Until 150 years ago, the sun and wood provided most of the energy. In many parts of the world they still do today

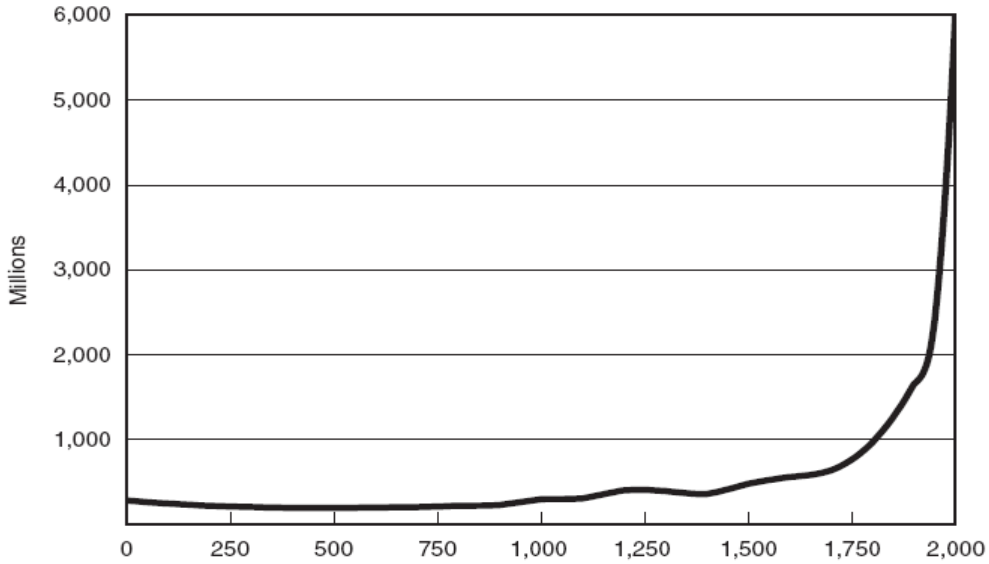
Energy - Developments

- The first energy crisis: occurred early in the Industrial Revolution when wood demand for housing, heating and the new industries of glass and metal making exhausted a natural resource

- The crisis turning into calamity was averted by the discovery of coal in England and North America

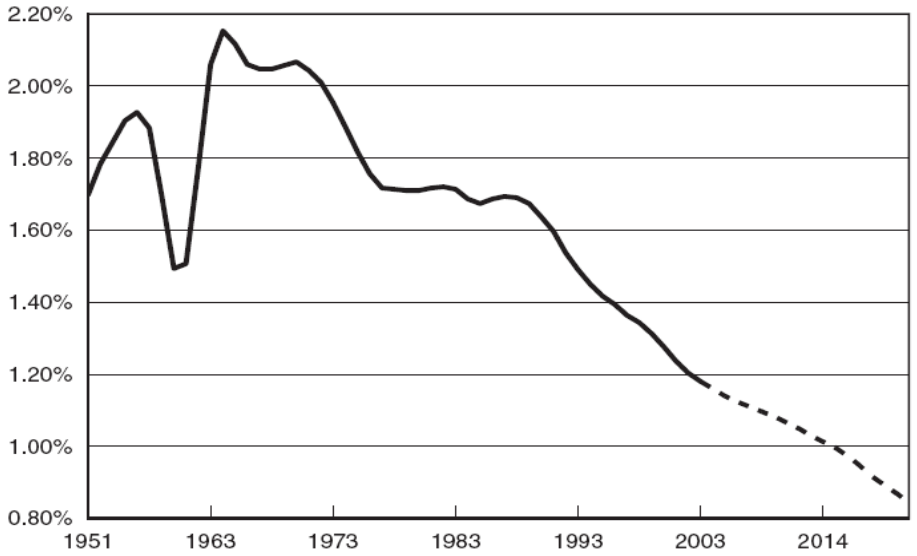
- Burning wood or biomass faster than it could be replaced by natural growth adds CO_2 to the atmosphere

History of Global Population



Year	Billion
1840	1
1930	2
1960	3
1974	4
1987	5
1999	6

Percent increase in world population



Roy L. Nersesian, Energy for the 21st Century, 2007, M.E.Sharpe, Inc., New York

Energies and their conversion

from / to	electro-magnetic	chemical	thermal	kinetic	electrical	nuclear	gravitational
electro-magnetic		chemiluminescence	thermal radiation	accelerating charge phosphor	electro-magnetic radiation electro-luminescence	gamma reactions nuclear bombs	
chemical	photo-synthesis photo-chemistry	chemical processing	boiling dissociation	dissociation by radiolysis	electrolysis	radiation catalysis ionization	
thermal	solar absorption	combustion	heat exchange	friction	resistance heating	fission fusion	
kinetic	radiometers	metabolism muscles	thermal expansion internal combustion	gears	motor electro-strictions	radioactivity nuclear bombs	falling objects
electrical	solar cells photo-electricity	fuel cell batteries:	thermo-electricity thermionics	conventional generator		nuclear batteries	
nuclear	gama-neutron reactions						
gravitational				rising objects			

Most common forms of energy

- Heat (thermal energy)
- Motion (kinetic or mechanical energy)
- Light (electromagnetic energy)
- Chemical energy of fuels and foodstuffs

Key Persons

- Isaac Newton (1642–1727)
- James Watt (1736–1819) – steam engine
- Carnot (1796–1832) – maximum efficiency of ideal heat engine
- James Prescott Joule (1818–1889) – the equivalence of heat and mechanical work (The law of conservation of energy)
- Rudolf Clausius (1822–1888) - the maximum performance obtainable from an engine using the Carnot cycle depends solely on the temperatures of the heat reservoirs, not on the nature of the working substance; and that there can never be a positive heat flow from a colder to a hotter body (direction of energy transformation – entropy1865 – second law of thermodynamics)

Key Persons (contd.)

- Walther Nernst (1864–1914) – third law of thermodynamics, at absolute zero temperature entropy is zero
- Marie Curie (1867-1934) – on the spontaneous radiation emitted by uranium compounds
- Albert Einstein (1879–1955) – mass is itself a form of energy ($E = mc^2$—energy is equal to the product of mass and the square of the speed of light). As a result, just four tonnes of matter contain energy that is equivalent to the world's annual consumption of commercial energy.