ENE 101 – Introduction to Energy Engineering

WEEK 1

Energy basics:

- **What is energy?**

➢ The word '**ENERGY**' itself is derived from the Greek word 'en-ergon', which means 'in-work' or 'work content'.

➢ ***Energy*** is ***"the capacity to do work".*** It is the power to create, shape, transform and animate***.*** "**Work**" is the action of moving something against a force. The work output depends on the energy input.

➢ Energy is always conserved (or converted into mass) so is incredibly useful in working out the results of any kind of physical or chemical process.

➢ It' s essential to modern life. We depend on energy.

- **History of Energy**

The history of energy consumption shows how important energy is to the quality of life for each of us.

It can be examined through three ways:

➢ Before Industrial Revolution

➢ Industrial Revolution (1750-1850)

➢ After Industrial Revolution

Before Industrial Revolution

- For heat: sun and burned wood, straw, and dried dung were used.
- For transportation: horses and the power of the wind in our sails were used.
- For work: animals were used to do jobs that we couldn't do with our own labor. Water and wind drove the simple machines that ground our grain and pumped our water.

Industrial Revolution (1750-1850)

- Machines replaced human/animal labor in manufacture and transportation
- Steam engines for heat energy into forward motion were started to used.
- A single steam engine, powered by coal, could do the work of dozens of horses.
- Changes in agriculture, manufacturing, mining, transportation and technology ultimately affected social and economic conditions.

After Industrial Evolution

- Steam engines were soon powering locomotives, factories, and farm implements.
- Coal was used for heating buildings and smelting iron into steel.
- In 1880, coal powered a steam engine attached to the world's first electric generator.
- Thomas Edison's plant in New York City provided the first electric light to Wall Street financiers and the New York Times.
- By the late 1800s, a new form of fuel was catching on: **petroleum**. By the turn of the century, oil, processed into gasoline, was firing internal combustion engines.
- Energy use grew quickly, doubling every 10 years.
- The cost of energy production was declining steadily, and the efficient use of energy was simply not a concern.
- After World War II (1939 to 1945) unleashed nuclear power, the government found it in electricity production. Over 200 nuclear power plants were planned across the country, and homes were built with all-electric heating systems to take advantage of this power.
- Gasoline use grew unchecked as well. Cars grew larger and heavier throughout the 1950s and 1960s. By 1970, the average mileage of an American car was only 13.5 miles per gallon, and a gallon of gas cost less than a quarter.

Nowadays

- More cars:
  - Job growth in automobile-related industries
  - Major role in development of industrialized nations.
- Cars altered people's lifestyles:
  - Vacationers—greater distances
  - People could live farther from work
    - Led to cities and suburbs.
    - Labor-savings, energy-consuming devices became essential
    - Energy dependent
- Within 200 years, energy consumption of industrialized nations increased eightfold.
- The invention of the automobile :
  - Increased the demand for oil products
  - 2% in 1900 to 40% in 2010

- **Energy Consumption and Standard of Living**

Consumption of a large amount of energy in a country indicates increased activities in these sectors. This may imply better comforts at home due to use of various appliances, better transport facilities and more agricultural and industrial production. **All of this amount to a better quality of life.** Therefore, the ***per capita energy consumption of a country is an index of the standard of living*** or prosperity (i.e. income) of the people of the country.

- **Energy distribution between developed and developing Countries**

Although 80 percent of the world's population lies in the developing countries their energy, consumption amounts to only 40 percent of the world total energy consumption. The world average energy consumption per person is equivalent to 2.2 tons of coal. In industrialized countries, people use 5 times more than the world average and 9 times more than the average for the developing countries.

- **Energy balance**

Energy balances provide overviews, which serve as tools for analyzing current and projected energy positions.

Source + Import= export + variation of stock + use + loss

Energy data are to be translated into economic terms, for a further analysis of options for action.

It is useful for purposes of resource management, or for indicating options in energy saving, or for policies of energy redistribution, etc. However, care must be taken not to single out energy from other economic goods. That means that an energy balance should not be taken as our ultimate guide for action.

- **Energy units and dimensions**

  Basic SI units: m, kg, s etc.
  Derived SI units: W/m^2, m/s^2, j/kg, N/m, j/s etc.

- **Forms of Energy**

  Kinetic Energy, Potential Energy, Thermal Energy, Mechanical Energy, Electrical Energy, Magnetic Energy, Chemical Energy, Nuclear Energy, Gravitational Energy and so on.

- **What is energy conversion**

  - Energy conversions means converting energy from one form into another.
  - No energy can be created or destroyed.
  - All we can do is transform or convert energy from one form into another.
  - In all conversions, we find that part of the energy is lost. This does not mean that it is destroyed, but rather that it is lost for our purposes, through dissipation in the form of heat or otherwise.

Examples of energy conversion: We convert radiation energy into electricity with photovoltaic cells, whereas with light bulbs we do the reverse. Wind turbine generates energy, which means it converts kinetic energy from wind into mechanical energy. Diesel engine generates energy, which means that the engine converts chemical energy of oil into mechanical energy.

- **Energy losses and efficiency**

  η = (output energy) / (input energy)

- **Renewable vs. Non-Renewable Energy Resources**

  Renewable Energy is energy obtained from sources that are essentially inexhaustible. Examples of renewable resources include wind power, solar power, geothermal energy, tidal power, and hydroelectric power. The most important feature of renewable energy is that it can be harnesses without the release of harmful pollutants.

  Non-renewable energy is the conventional fossil fuels such as coal, oil, and gas, which are likely to deplete with time.

- **Non-renewable energy resources**

  ➢ Conventional energy resources (COAL, OIL, GAS) : They are *global primary energy reserves*.
  ➢ Product-Market Consumption Trends of Conventional Energy Sources
  ➢ Investigations of demands region by region from 2014-2020.

References:

1. International Energy Agency: Excellent source of Global statistical information. http://www.iea.org

2. http://www.ourenergypolicy.org/growing-poor-slowly-why-we-must-have-renewable-energy/
3. http://www.fao.org/docrep/u2246e/u2246e02.htm
4. BP Statistical Review of World Energy, EIA, FERC, and Reuters