

# ENE 101 – Introduction to Energy Engineering

## WEEK 2

### Climate:

- **Energy Challenge**

- Energy use is directly proportional to standard of living.
- Things have changed dramatically since the industrial revolution.
- World population is expanding rapidly.
- Energy demand is skyrocketing.
- Global reserves of various types of fossil energy are limited.
- Oil and natural gas will be fully depleted in 50 years, and coal in 300 years.

- **Fossil Fuels**

Fossil Fuels are non-renewable as they are formed from the remains of microbes, plants, and animals that lived millions of years ago.

**Advantageous:** Much less expensive than other sources

**Disadvantageous:** Non Renewable, releases CO<sub>2</sub> into the air contributing to climate change, obtaining fossil fuels destroys habitats, causes pollution including acid rain.

### **COAL**

- When coal is burnt it produces Nitrogen Oxides, Carbon Dioxide, Nitrogen Oxide and mercury compounds.
- Since coal contains impurities like S and N, it produces toxic gases during burning which causes acid rain and air pollution. Gives off sulfur dioxide-harms trees.
- Lakes and rivers are contaminated from coal power plants.
- Severe human health threat. (lung).

**Table 1. Coal gas emission products**

| <b>Pollutant</b> | <b>Coal (Pounds per Billion BTU of Energy Input)</b> |
|------------------|--|
| Carbon Dioxide   | 208000   |
| Carbon monoxide  | 208  |
| Nitrogen Oxides  | 457  |
| Sulfur Dioxide   | 2591   |
| Particulates     | 2774   |
| Mercury          | 0.016  |

## **OIL**

- Crude oil is made of many different compounds, each with its specific boiling point. Using distillation, we can separate out these compounds and turn them into commercial products, ranging from gas to asphalt.
- Methane from oil wells & equipment.
- Natural gas burned from oil production.
- Harmful to fish and plants.

**Table 2. Oil gas emission products**

| <b>Pollutant</b> | <b>Oil (Pounds per Billion BTU of Energy Input)</b> |
|------------------|---|
| Carbon monoxide  | 33  |
| Nitrogen Oxides  | 448   |
| Sulfur Dioxide   | 1122  |
| Particulates     | 84  |
| Mercury          | 0.007   |

## **• Natural Gas**

- Natural gas is found above the oil in oil well. It is the mixture of 50-90% methane and small amount of other hydrocarbons.
- Release Nitrogen Oxides, Carbon Dioxide & Carbon monoxide when burned.
- Methane (a greenhouse gas) can leak from pipelines.
- Less emissions than coal and oil.
- Methane sometimes emitted or leaked

- ❑ Affects people and animals who depend on aquatic life in lakes and rivers

**Table 3.** Natural Gas emission products

| Pollutant       | Natural Gas ( <i>Pounds per Billion BTU of Energy Input</i> ) |
|-----------------|---|
| Carbon monoxide | 40  |
| Nitrogen Oxides | 92  |
| Sulfur Dioxide  | 1   |
| Particulates    | 7   |

- **Nuclear Energy**

- ❑ Nuclear Energy is a non-renewable resource because once uranium is used, it is gone!
- ❑ Nuclear Fission uses uranium to create energy
- ❑ The nucleus of a uranium atom stores a large quantity of nuclear energy.
- ❑ When these atoms break apart, the atoms' nuclear energy is transformed into thermal energy.
- ❑ A small pellet of uranium-produces about as much energy as burning **570 L** of oil.
- ❑ Fission of 1 kilogram of uranium releases more energy than does burning 3 million kg of coal.

**Advantageous:** Fuel required is quite small, nuclear power plant requires less space, economical for bulk electric power, ensure continued supply of electrical energy, do not cause air pollution, does not emit greenhouse gases

**Disadvantageous:** Non-renewable, fuel is expensive, capital cost is very high, requires greater technical knowledge, radioactive fission products/waste, mining uranium causes pollution, risk of serious accidents, radioactive waste from a nuclear reactor is stored *underwater* for more than 10 years. Then it is stored in a dry storage behind *concrete* 1 m thick. After another 60 years, the canisters can be moved to *long-term storage*, but it is still *unsafe*. It will remain unsafe for *tens of thousands of years!* Aquatic life badly affected because of water removal.

- **Energy and Environment**

- ❑ Energy and environment has a strong relationship. The production and consumption of energy is one of the biggest causes of environmental damage on earth.
- ❑ It leads to large amounts of destruction of natural landscapes and habitats through the process of fuel extraction, pollution of soil, climate change.
- ❑ Energy is at the heart of many of the world's current environmental problems, and possess many problems for the sustainable development.
- ❑ Examples: Air pollution in China and India
- ❑ Energy production includes environmental and human health costs: Smog, Acid Rain, Global Warming, Asthma, Cancer, Neurological Toxins

- **Most Consequential Types of Waste**

Nitrogen Oxides (NO, NO<sub>2</sub>), Carbon Dioxide (CO<sub>2</sub>), Sulfur Dioxide (SO<sub>2</sub>), Mercury Compounds, Lead Compounds, Methane (CH<sub>4</sub>), Ozone (O<sub>3</sub>) at ground level, Chlorofluorocarbons (CFCs), Unburned hydrocarbons

- **What is Acid Rain?**

Acid rain, or acid deposition, is a term that includes any form of precipitation with acidic components, such as sulfuric or nitric acid that fall to the ground from the atmosphere in **wet** or **dry forms**. This can include rain, snow, fog, hail or even dust that is acidic.

The major sources of SO<sub>2</sub> and NO<sub>x</sub> in the atmosphere are industrial power plants, factories, vehicles. Also, burning of fossil fuels, such as natural gas, coal, or even oil, releases oxides of sulfur and nitrogen.

Harmful effects of acid rain: Acid rain kills plants and vegetation by damaging their roots, leading to deforestation in many parts of the world. In addition, it corrodes buildings, bridges, statues and other structures made of metal or stone. Acid rain kills fishes in lakes.

- **Green House Effect**

The Earth maintains a habitable temperature due to the Green House Effect. It allows heat from the sun to penetrate our atmosphere, where it is absorbed by the Earth's

surface or radiated out and reflected back to Earth by greenhouse gases in the atmosphere.

The most important greenhouse gases are carbon dioxide, methane, nitrous oxide and water vapor.

Annual Greenhouse gas emissions were discussed according to the sectors.

- **Observations of Climate Change – Global Warming**

Temperature, evaporation & rainfall are increasing, corals are bleaching, glaciers are retreating, sea ice is shrinking, sea level is rising, wildfires are increasing, hurricane, and storm and flood damages are much larger.

**Examples:** Tropical Glaciers in Peru are almost finished, dead trees and forest in Germany

- **Evidences That Humans Are Causing Global Warming**

According to the Union of Concerned Scientists, there are several indications that provide evidence that humans are the major cause of global warming rather than it being due to natural variability – these indicators include warming oceans, atmosphere boundary shifts, rising surface temperatures etc.

- **World Energy Consumption**

15 TW /year (for 2008) = 15.000.000 MW

We still strongly depend on fossil fuels and this is not expected to change anytime soon.

- **The Energy Solution**

Development of **efficient and sustainable energy** technologies is necessary for taking the next big step in **renewable energy usage**.

**References:**

1. [http://www.paulchefurka.ca/WEAP2/Energy\\_GDP\\_2050.html](http://www.paulchefurka.ca/WEAP2/Energy_GDP_2050.html)
2. <http://globalwarming-facts.info/causes-global-warming-human/>
3. <https://helpsavenature.com/acid-rain-solutions>