

Course Overview

- ✓ Course code: ESE404
- ✓ Pre-requisite: EMP301
- ✓ Credit hours: 3 hrs
- ✓ Contact hours: Sunday from 9:00 am-11:00 am
- ✓ Tutorial : Sunday from 11:00 am-1:00 pm
- ✓ Marks: 100 (60+40)
- ✓ Marks distribution: 30% mid 1 + 20% mid 2 + 10% attendance + 40 % final



Course Topics

- Bio-energy: Origin – Types- characteristics- technology of production and cost.
- Biomass resources: agriculture energy crops, woody crops (trees)
 - crops residues – forest residues – animal wastes
- Advantages and disadvantages of different biomass resources
- Thermal, chemical and biochemical conversion
- Uses and markets of biofuels
- Technology for producing Bio-power: combustion and gasification – steam or gas turbines, fuel cells, anaerobic digestion of manures to produce methane

Course Objectives

- To understand the basic principles of Bioenergy.
- To differentiate between non-renewable and renewable energy resources.
- To differentiate between the different biomass resources.
- To learn how to produce biofuels from biomass.
- To compare between the characteristics of each biofuel.
- To be familiar with Thermal, chemical and biochemical conversion taken place in the biofuels production.
- To understand the basics of combustion and gasification
- To relate the cost of biofuel production to its benefits.

Four Main Parts to be Covered

Bioenergy Resources

Production of Biofuels

Applications of Bioenergy

Bioenergy Economics Concerns

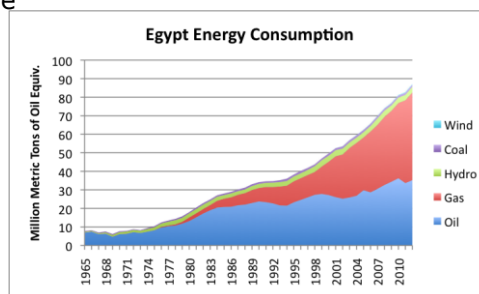
World Energy Picture

Our Needs: electricity, transport, heat

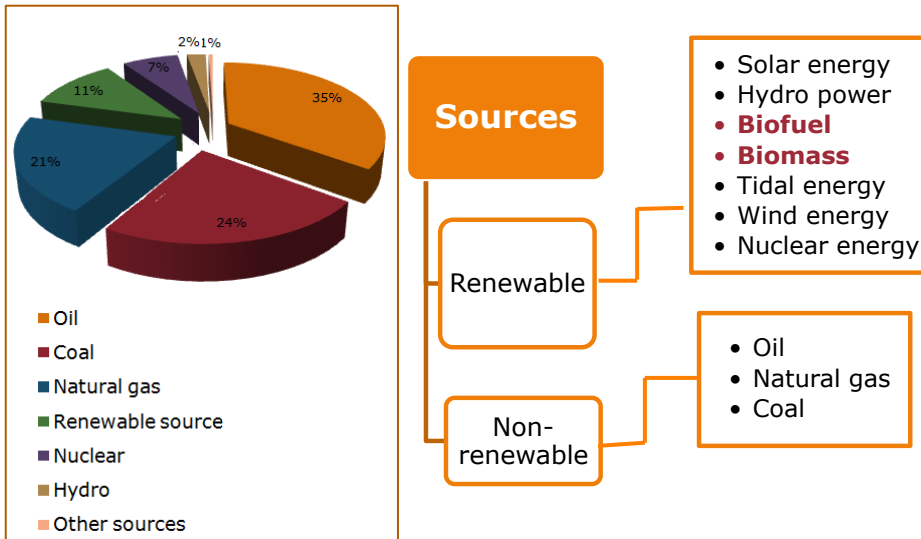
Requirements: coal, oil, gas

Challenges and Concerns:

- Pollution & Climate Change .
- Resource Depletion, Security.
- Rapid increase in population, increase in energy demand.
- Price: people can't afford the energy they want.



Types of Energy Resources



WHY RENEWABLE ENERGY?

- ❖ The fast growing population, and industrialization have increased the demand of energy in developing countries.
- ❖ The current demand of energy depend on sources are non-renewable in nature such as fossil fuels.
- ❖ Up to 2040, all the resources of fossil fuels will be finished.
- ❖ So for this reason scientist are focus their view on the alternative renewable energy resource such as solar energy, biogas, biodiesel, wind power, tidal energy etc.



What is fuel?, Can you imagine life without it?

- ❖ **Fuels** are any material that stores potential energy in forms that can be released and used as heat.
- ❖ They are required for a variety of purposes such as:
 - 1) Transportation: it accounts for 25% of energy demand and nearly 62% of oil consumed.
 - 2) Electricity Generation:
 - The generation of electricity is the single largest use of fuel in the world.
 - More than 60 % of electricity generated comes from fossil fuels.

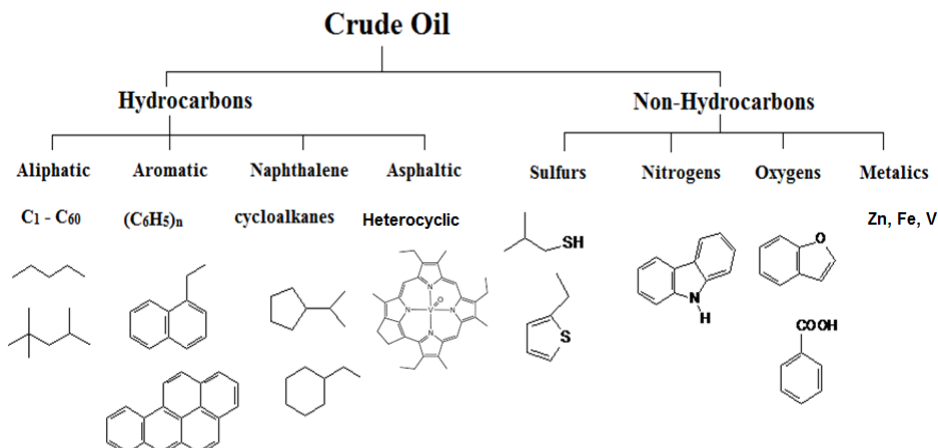
Chemical composition of fuel



- ❖ Petroleum (black gold) is a complex, naturally occurring liquid, and in usages it includes crude oil and natural gas also.
- ❖ It is a mixture of hydrocarbons, and some compounds of oxygen, nitrogen and sulfur.
- ❖ It contains four different forms of hydrocarbons with different molecular weights, chemical properties, and organic structures.
- ❖ Most of the world's petroleum is to be found in the Middle East.
- ❖ Natural gas contains hydrocarbons in gaseous forms, and methane (CH₄) is the major component.

Element	Wt. %	Hydrocarbons	Wt. %
Carbon	83-87	Alkane	30
Hydrogen	10-14	Naphthalene	49
Nitrogen	0.1-2	Aromatics	15
Oxygen	0.1-1.5	Asphaltic	6
Sulfur	0.5-6		
Metals	< 0.1		

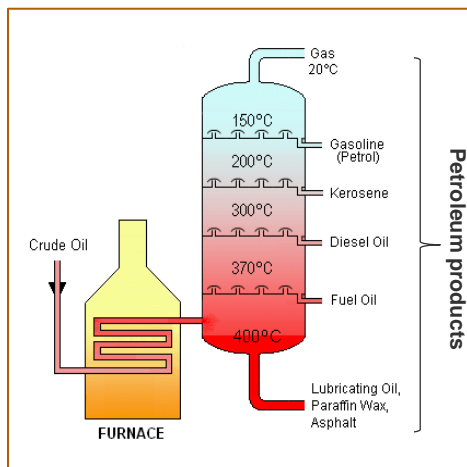
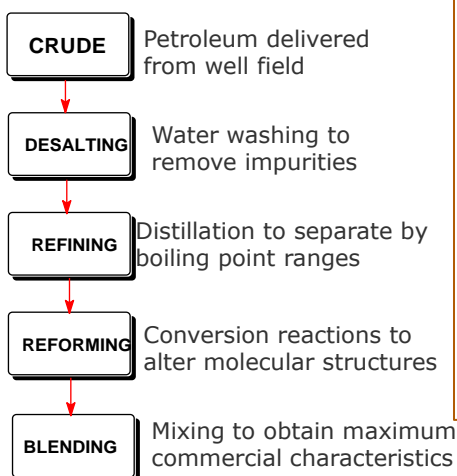
Composition of Crude Oil



Any compound in petroleum contains from 1 to about 60 carbon atoms. They consist of straight chains or cyclic chains of carbon atoms.

Refining of Crude Oil

During refining of crude oil, the lighter hydrocarbons (gases) move up in the distillation tower.



Schematic representation of distillation towers

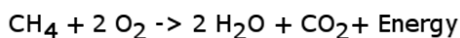
Important Chemical Reactions in Petroleum

➤ Cracking processes take place in petroleum refining to break down heavy hydrocarbons into lighter products. The catalyst used is often silica or alumina

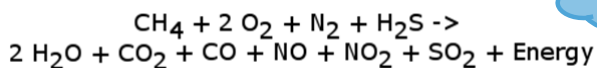


➤ **Combustion of some petroleum products**

1- Combustion of clean products such as natural gas and gasoline:



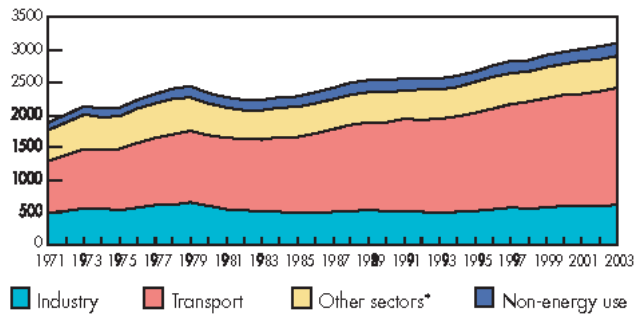
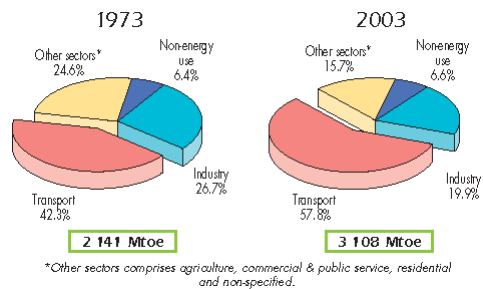
2- Combustion of Petroleum Contaminants:



Acid rains

Use of Oil

Mainly in transportation –
industry – power production
– synthesis of plastics

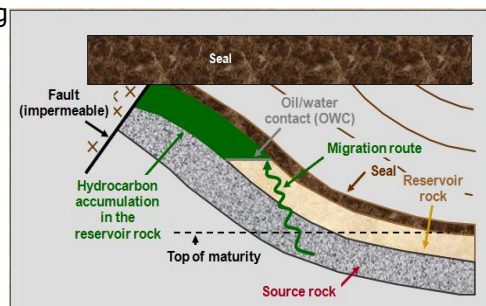


Problems and disadvantages of fossil fuel

Fossil fuels: They are hydrocarbon fuels that take millions years to be formed.

- They are nonrenewable (once used it is no longer available)
- They are very hazardous and cause environmental pollution because their burning releases CO₂ or CO.
- Their prices are always in rising
- Power stations consume lots of fuel and effort to generate electricity, they will be stopped if there is reduction in fuel.

What is the solution !!!!



Alternative energy – Bioenergy

➤ **Bioenergy** is energy produced from recently living organic matters called biomass. These matters can be burned directly for heat (traditional biomass) or converted to **biofuels** such as biodiesel or ethanol.

➤ **Types of bioenergy resources:**

- **Biofuels**

- ❖ Liquids: Methanol, Ethanol, Butanol, Biodiesel
- ❖ Gases: Methane, Hydrogen



- **Bioheat**

- ❖ Wood burning



- **Bioelectricity**

- ❖ Combustion in Boiler to Turbine
- ❖ Microbial Fuel Cells (MFCs)



History of Bioenergy

Bioenergy is not new!!!!

- Biomass such as wood & crops are used to burn for heat and lightning long time ago.
- 1850s: Ethanol used for lighting.
- 1896: 1st ethanol-fueled automobile, the Ford Quadricycle.
- 1908: 1st Ford Model T working with ethanol
- WWI and WWII: Ethanol used due to high oil costs.
- 1990s: The most recent biofuel popularity



Increased in response to high emissions standards and increasing demands for enhanced fuel economy.

Alternative and renewable fuel



Biofuels:

- Any hydrocarbon fuel that is produced from living organic matter in a short period of time (days, weeks, or months).
- They are alternative of fossil fuels, so they are ways of energy security.
- They burn cleaner than fossil fuels, resulting in fewer emissions of greenhouse gases or substances that cause acid rain such as sulfur.
- They are biodegradable, so when spill, less harm is done compared to when fossil fuels spill.

Why biofuels?

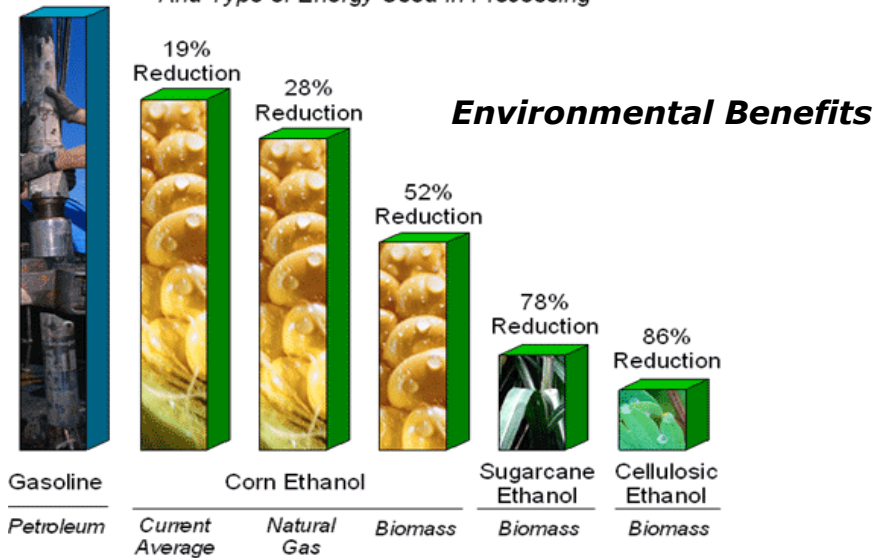
There are many reasons forced us to use biofuels:

1. To reduce our dependence on fossil fuels
2. To reduce reliance on foreign oil
3. To lower emissions of green house gases
4. To bring business to rural economics

Advantages of biofuels

1. Locally available in every region of the world.
2. Friendly with the environment: do not cause global warming – do not emit any hazardous gas
3. Highly energetic: the energy release per unit mass of biofuel is greater than that of fossil fuels.

Greenhouse Gas Emissions by Transportation Fuel
And Type of Energy Used in Processing



Sources: Wang et al, *Environ. Research Letters*, May 2007; Wang et al, *Life-Cycle Energy Use and GHG Implications of Brazilian Sugarcane Ethanol Simulated with GREET Model*, Dec. 2007