Energy and Climate : Sustainable Development

Energy and Climate : Sustainable Development

- Energy is the prime needs to our society for heating, cooling, electricity and transportation which is a major driver for the emission of greenhouse gases hence the consequences of climate change and impacts on human health.
- The overall purpose of the Module is to introduce the concept of energy (renewable and non-renewable) and climate change within a context of sustainable development.
- Climate change is one of the major challenges of our time and adds considerable stress to our societies and to the environment.

Cont'd……

- The Energy and Climate change module is to introduce the overview of renewable and non-renewable energy and concept of climate change and its impacts on human health.
- Students will acquire the knowledge to understand technical, social and spatial dimensions of energy systems and how these interact with environmental parameters to change the climate.
- Also obtain knowledge and experience of some of the key technologies used in developing renewable energy and protecting the environment.

Cont'd……

- The module is delivered with the aid of the Moodle platform and may either be presented as face-to-face lectures or, alternatively, as a series of lecture videos for asynchronous learning.

Module details

Programme title: Department of Geology and Mining, Faculty of Science and Engineering

Level: BS (Honours)

Module title: Energy and Climate: Sustainable Development

Module credits: 2 ECTs

Semester(s)/Year in which to be offered: Two semester (3 and 4) full time, yearly intake, 2021-2022 Session

Indicative learning hours: 50 hours (30 hours of lectures; 20 hours of independent work)

Module tutors: 1 (Dr. Dhiman Kumer Roy)

Aim of the module

- Introduce students to basic physical principles of different sources of energy, production, how they can be obtained.
- Provide ideas on how to perform feasibility studies related to the sources of energy, how to quantify, and evaluate any environmental and economic issues.
- Module provides knowledge on energy science and system based on current consumption of fossil fuels and its impacts on the society.
- Make students aware of energy policy and possible energy strategies to preserve economic prosperity, and protect environment.

Aim of the module

➢ Encourage students to understand the crucial role of energy in the society and implications stemming from their own consumption of energy.

➢Explain the production of energy methods from renewable sources.

➢Provide necessary concept, knowledge and skills on climate change topics related to the possible causes and impacts of climate change and the role being played by anthropogenic effects.

➢Explain and identify the natural and anthropogenic drivers of climate change and geological history of earth's climate.

Learning outcomes

➢ This course provides clear, concise, lucid and up-to-date information in obtaining basic understanding about energy and climate change.

➢This module will be of great benefits to students and researchers and of particular interest to the civil servants in ministries, environmental managers in private and civil sectors and interested citizens.

➢ It is anticipated that successful completion of this module will benefit students both in terms of developing their knowledge and understanding in the area of energy and climate change.

Learning outcomes

➢After studying the module in the context of energy and climate change, a student should be able to

Knowledge and Understanding

•Understand the energy flow in the Earth's system, exploration, production, transportation, conservation and consumption

•Explain the differences between renewable and non-renewable energy sources

•Identify renewable and non-renewable energy sources and use and effectiveness of energy sources.

•Demonstrate understanding of the different types of renewable energy technologies to provide energy.

•The perspectives on climate change causes, impacts and mitigation/adaptation possibilities from a range of sciences: natural science, economics, political science and sociology

Learning outcomes

➢After studying the module in the context of energy and climate change, a student should be able to

Knowledge and Understanding•

•The basic association of climate change with human energy requirements

•The impacts of climate change on natural resources, especially air, and consequent effects on human health

•This course provides students with basic theoretical knowledge and techniques for understanding, assessing, and mitigating environmental issues

•Understand key components of energy systems in the world, including opportunities and limitations from resource, technology, environmental and social perspectives;

Learning outcomes

Transferable/Key Skills and other attributes

On completion of the module a student will have had the opportunity to:

•Evaluate the advantages and disadvantages of renewable and non-renewable energies and technologies

•Able to create a potential list of appropriate renewable energy that can be used in a particular socio-economic condition

•Able to evaluate the impacts of renewable and non-renewable energy resources and its impacts on global climate and human health.

•Students will be able to conduct an independent, limited research or development project in renewable energy systems.

Semester dates and module structure

The module is intended to be taught during the 2021-2022 Session of 2nd year (3 and 4 semester). The face-to-face and or online lectures will be arranged as a single, 60 minutes lecture (each).

Lecture No	Lecture topic
1, 2, 3 & 4	Energy and Fossil Fuel
5	A journey of fossil fuel from field to market
6 & 7	Biomass
8 & 9	Solar Energy
10, 11 & 12	Hydropower Energy
13, 14, 15 & 16	Nuclear Energy
17 & 18	Geothermal Energy
19 & 20	Climate Change and Causes
21 & 22	Indicators of Climate Change
23, 24 & 25	Global Effects of Climate Change
26 & 27	Global Impacts – Air pollution

Module assessment

Grade Letter	Grade Point	Marks Obtained (%)	Generalized description of competence in the subject
A+	**4.00**	**80-100**	**Excellent understanding and application of concepts and skills**
A	**3.75**	**75-79**	**Very Good understanding and application of concepts and skills**
A-	**3.50**	**70-74**	**Good understanding and application of concepts and skills**
B+	**3.25**	**65-69**	**Basic understanding and applications of concepts and skills;**
B	3.00	60-64	**Very Basic understanding and applications of concepts and skills;**
B-	2.75	55-59	Limited acquisition of intended course outcomes
C+	2.50	50-54	Very Limited acquisition of intended course outcomes.
C	2.25	45-49	Comprehensive theoretical understanding of the subject and correct performance of standard calculations demonstrated without errors.
D	2.00	40-44	Very limited demonstrate the required understanding and application of concepts and skills
F	0.00	<40	Does **Not** yet Demonstrate the required understanding and application of concepts and skills; students with a final grade of less than 40% are not granted course credit.

ENERGY and Fossil Fuel

Introduction to the Lecture

- This lecture provides an overview of the module. It introduces the module's objectives, content, structure, technical information and the forms and criteria of assessment and the course reference materials.
- This lecture has 2 parts.
- This lecture introduces the basics of energy science. It provides an overview of key concepts such as energy and power, global energy scenario in relation to the fossil fuel, world global problem.

Introduction to the Lecture

- Part 1 describes the overview of energy use and related issues, energy consumption patterns, economic and environmental considerations, renewable and non-renewable energy sources.
- Part 2 provide an overview of fossil fuels, world production of fossil fuels, formation of fossil fuels, types of fossil fuels, declining fossil fuel, fuel efficiency, fossil fuel resources, production

Contd…

- and consumption, resource and reserve, coal reserved and mining, environmental concern, carbon dioxide in the atmosphere, global fossil carbon emission, emission of carbon dioxide, carbon dioxide and global mean temperature, production of electricity from fossil fuel.

Learning outcomes

- After completing lecture "Energy and fossil fuel" students will be able to:
- Access all relevant module information and materials;
- Understand the scope of the module;
Know the basic concept of energy and energy sources.
- Explain the energy flow in the Earth's system, exploration, production, transportation, conservation and consumption;

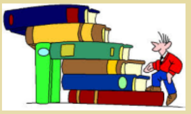
Learning outcomes

➢ After completing lecture “Energy and fossil fuel” students will be able to:

➢ Identify the principal energy sources used worldwide, and classify them either renewable or non-renewable;

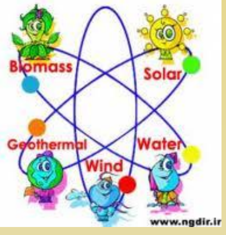
➢ Know the reason of declining fossil fuel and the increasing rate of carbon dioxide in the atmosphere.

Books and Reference

Textbook 	Hinrichs, R. and Kleinbach, M. 2006, Energy, its Use and the Environment, 4th Edition, Cengage Learning.
Supplemental book and materials: 	Ristinen, R.A, and Kraushaar, J.J., 2006. Energy and the Environment. John Wiley & Sons Inc. Related website address will be given (if necessary).

ENERGY and POWER

- **Work** is the application of force through a distance.
- **Energy** is the capacity to do work.
- **Power** is the rate of flow of energy, or the rate at which work is done.



Global Energy Scenario

❑ Energy has become a vital component of human life

❑ Energy is also an indicator of economic and social improvement

❑ Most of the energy supply utilized worldwide, from non-renewable energy resources

❑ relationship between energy supply and economic growth and development is evident

❑ Consumption of fossil fuels is dramatically increasing

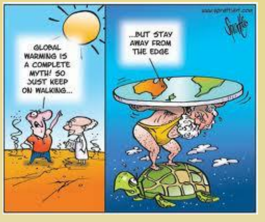
❑ Excessive fossil fuel consumption not only leads to an increase in the rate of diminishing fossil fuel reserves

❑ it also has a significant adverse impact on the environment, resulting in increased health risks and the threat of global climate change

❑ Therefore, it is important to understand energy resources and their limitations, as well as the environmental consequences of their use.

Problem and Questions

1. How do this energy form?
2. Where are they found?
3. How long will the supplies of these vital energy last?
4. What will do when they are exhausted?
5. What happen on environment?
6. How to control the effects of use these energy on environment?



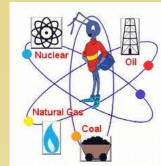
World Global Problems

- Decrease in fossil fuel reserves due to world population growth and increasing energy demand.

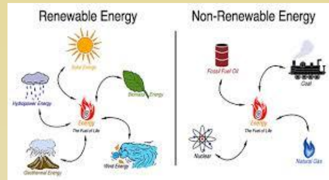
- Global climate change due to the increase of CO_2 concentration in the atmosphere.

- Increase in levels of wastes (solid/liquid) due to increase in population among world.

NONRENEWABLE AND RENEWABLE RESOURCES



Just a story



HMMMM....

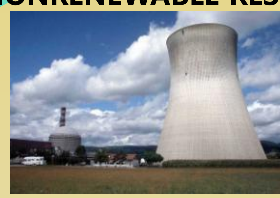
What do you think nonrenewable resources are?

Break it down...

Nonrenewable?

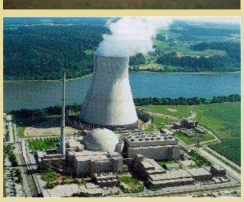
Resource?

NONRENEWABLE RESOURCES



A nonrenewable resource is a natural resource that cannot be re-made or re-grown at a scale comparable to its consumption.

NUCLEAR ENERGY

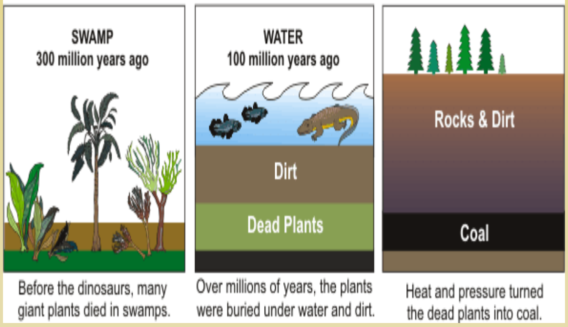


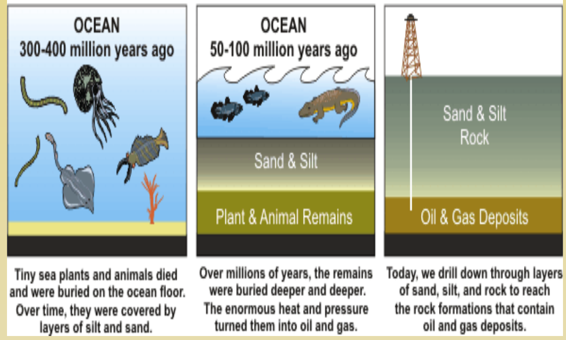
Nuclear fission uses uranium to create energy.

Nuclear energy is a nonrenewable resource because once the uranium is used, it is gone!

COAL, PETROLEUM, AND GAS

Coal, petroleum, and natural gas are considered nonrenewable because they can not be replenished in a short period of time. These are called fossil fuels.





WHAT WAS THE DIFFERENCE BETWEEN COAL AND OIL/GAS?



HMMMM....

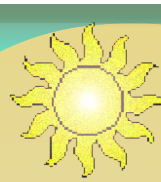
If nonrenewable resources are resources that cannot be re-made at a scale comparable to its consumption, what are renewable resources?

RENEWABLE RESOURCES

Renewable resources are natural resources that can be replenished in a short period of time.

- Solar
- Geothermal
- Wind
- Biomass
- Water

SOLAR




Energy from the sun.

Why is energy from the sun renewable?

GEOTHERMAL

Energy from Earth's heat.

Why is energy from the heat of the Earth renewable?

WIND

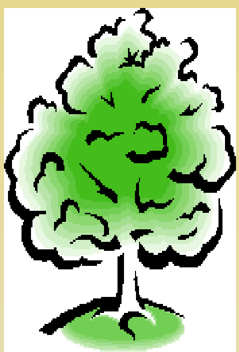
Energy from the wind.

Why is energy from the wind renewable?

BIOMASS

Energy from burning organic or living matter.

Why is energy from biomass renewable?



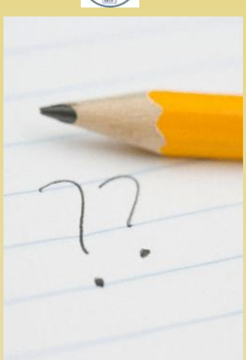
WATER or HYDROELECTRIC

Energy from the flow of water.

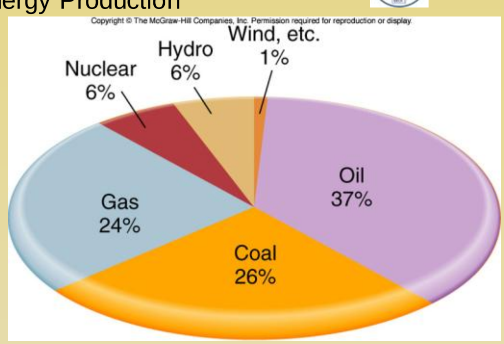
Why is energy of flowing water renewable?

SUMMARY

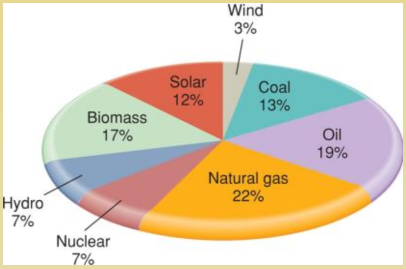
What are the differences between nonrenewable and renewable resources?



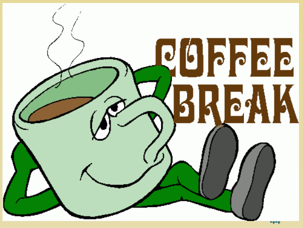
Worldwide Commercial Energy Production



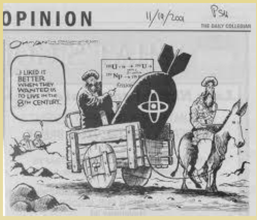
An Alternative Energy Future?



Let's have some questions!!!!!!!!!!!!!



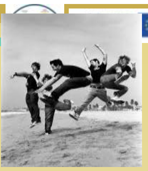
Energy Fundamentals and Use (Part 1)

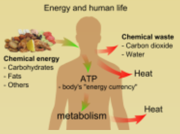


Robert A. Ristinen / Jack J. Kraushaar- Chap - 1

Introduction

- Energy involves our everyday lives in many different ways.
- Energy in food-essential for living beings- human, animal and plant
- Evolution of our planet related to energy...





Introduction

- Energy in forms other than food--essential for functioning of a technical society

- More energy goes in the form of engine fuel to produce food than we obtained in the food.

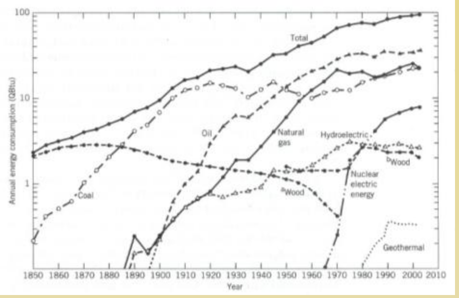
Introduction

To maintain the present patterns, we need vast amounts of energy.

- Fossil fuels (86%), solar, wind, hydro, nuclear etc
- Fossil fuels take long time MY to form.

- Muscular effort of human and animal and wood was the main energy source (150 years ago)
- Now we don't depend on muscle or animal.

Energy consumption- US since 1850



Ristinen & Kraushaar-Fig 1.1

Exploitation of world's fossil fuels

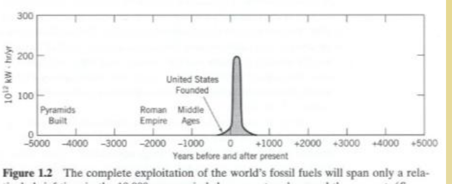
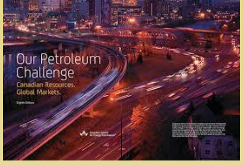


Figure 1.2 The complete exploitation of the world's fossil fuels will span only a relatively brief time in the 10,000 year period shown centered around the present. (*Source*: Reprinted with permission from M. K. Hubbert, *Resources and Man*, Washington, D.C., National Academy of Sciences, 1969. Historical events added.)

Why do we use so much energy

- We don't use our energy resources as efficiently as we could (US, Canada)



- Large discrepancy in energy consumption between the citizens of developed and developing country.

Gross domestic product per capita- US

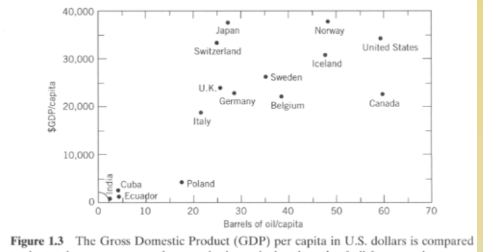


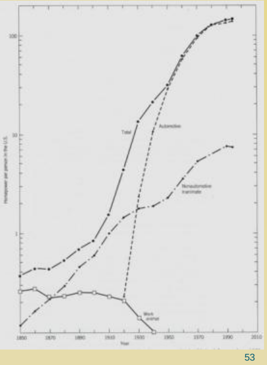
Figure 1.3 The Gross Domestic Product (GDP) per capita in U.S. dollars is compared to the total energy consumed per capita in equivalent barrels of oil for several countries. The small quarter-circle at the lower left corner is discussed in the text. (*Source*: *United Nations Statistical Yearbook*; data January 2003.)

- No relation with GDP and standard of living, however, relationship exists between GDP and energy consumption.

Horse power per capita-US

- Nonindustrialized country use their energy from muscle

- In 1850 in US one person needed 0.38 horsepower of which 0.26 came from animal



Energy Basics & Forms

What energy is ?

What forms it can take?

Nature of Energy

- Energy is all around you!
  - You can hear energy as sound.
  - You can see energy as light.
  - And you can feel it as wind.

Nature of Energy

- You use energy when you:
  - hit a softball.
  - lift your book bag / material.
  - compress a spring.

Nature of Energy

- What is energy that it can be involved in so many different activities?

  - Energy can be defined as the ability to do work.
  - If an object or organism does work (exerts a force over a distance to move an object) the object or organism uses energy.

Nature of Energy

- Because of the direct connection between energy and work, energy is measured in the same unit as work: joules (J).
- In addition to using energy to do work, objects gain energy because work is being done on them.

Forms of energy

- Energy can transform from one form to another form without loss

Common forms of energy

1. Chemical energy
2. Heat energy
3. Mass energy
4. Kinetic energy
5. Potential energy
6. Electric energy
7. Electromagnetic Radiation

Chemical Energy

1. Chemical energy:

- Chemical energy is the energy stored in chemical bonds
- Energy released by chemical reaction

Ex: Coal, wood paper, burning

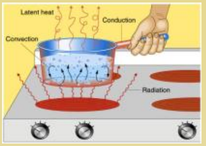
Chemical energy convert to heat energy

Heat Energy

Heat energy:

- Energy associated with random molecular motions within any medium, because moving particles produce heat.
- Thermal energy interchangeable with heat energy
- Heat energy is related to the concept of temperature

Increase heat increase temperature
Decrease heat decrease temperature



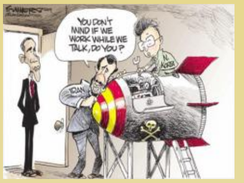
Mass Energy

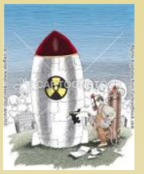
Mass energy: Energy comes from atomic nucleus, Ex- nuclear reactor and weapon

- Mass can be converter to energy
- Energy can be converted to mass (Albert Einstein)

E= mc^2

M-mass; C-speed of light





Kinetic Energy

- The energy of motion is called kinetic energy.
- The faster an object moves, the more kinetic energy it has.
- The greater the mass of a moving object, the more kinetic energy it has.
- Kinetic energy depends on both mass and velocity.

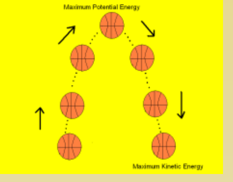
$$K.E. = 1/2\ mv^2$$

Potential Energy

Potential energy: Potential energy associated with forced field i.e. object position .

PE= w x h

w- weight at a height, h- height above the surface



Potential-Kinetic Energy

Kinetic-Potential Energy Conversion

Roller coasters work because of the energy that is built into the system. Initially, the cars are pulled mechanically up the tallest hill, giving them a great deal of potential energy. From that point, the conversion between potential and kinetic energy powers the cars throughout the entire ride.

Electrical Energy

Electric energy: Flow of electrons (or other charged particles)

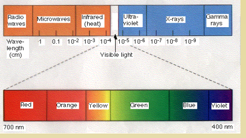
- Mechanical energy is converted to electric energy in a generator.

Electromagnetic radiation

Electromagnetic Radiation:

Energy in the form of a wave (energy radiated from the sun)

The energy radiated by the sun travels to the earth and elsewhere by electromagnetic radiation



POWER

Power is the time rate of using or delivering, energy

• Power = energy/time (rate of use energy)

• Energy = power x time (E = p x t) Joules per second

Units of Energy

• The Joule (J): is the metric unit of energy. One metric unit of force (N) acting through one metric unit of distance (m) is equivalent expenditure of one joule.

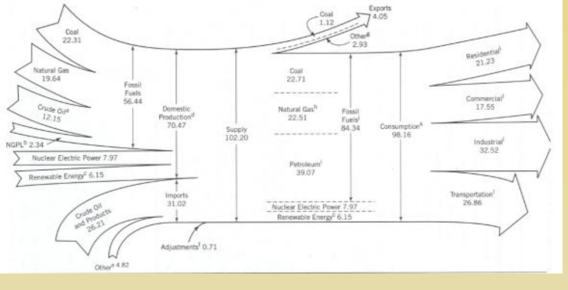
• The British Thermal Unit (Btu): amount of heat energy required to raise the temperature of one lb water by one degree Fahrenheit.

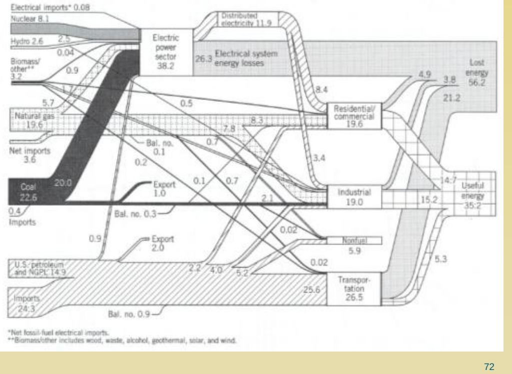
Units of Energy

• The Calorie (c): amount of energy required to raise the temperature of one gram of water by one degree Celsius. C ≠ c

• The Foot-Pound (ft-lb): A force of one pound acting through a distance of one foot by definition expends one ft-lb energy.

Energy consumption in the United States in 2003





World Energy consumption

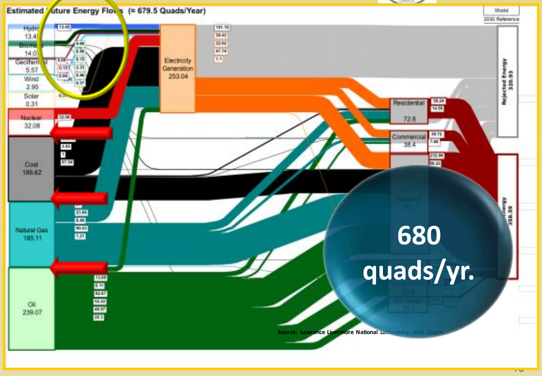


Figure 1.7 Each person in the United States consumes an energy equivalent of 58 barrels of oil burned as fuel each year.

Using generally available information, estimate the dollar value of the equivalent amount of oil which we each use annually.

Solution

Given:

58 barrel/(yr · person); see Figure 1.7.

42 gallons/barrel; see Energy Equivalents chart inside front cover.

Oil is approximately \$1.25/gallon; estimated from reported crude oil prices.

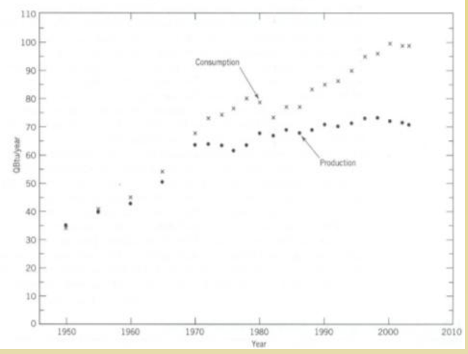
$$58 \frac{\text{bbl}}{(\text{yr}\cdot\text{person})} \times 42 \frac{\text{gal}}{\text{bbl}} \times 1.25 \frac{\$}{\text{gal}} = \mathbf{3045} \frac{\$}{(\mathbf{yr}\cdot\mathbf{person})}$$

Note that the units of bbl and gal cancel in this calculation. We can extend the answer to obtain the cost per day of this oil.

$$3045 \frac{\$}{(\text{yr}\cdot\text{person}} \times \frac{1\ \text{yr}}{365\ \text{day}} = \mathbf{8.34} \frac{\$}{(\mathbf{day}\cdot\mathbf{person})}$$

Here the units of yr have canceled.

Energy Consumption and Production



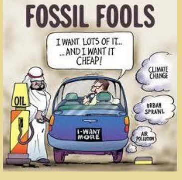
Fossil Fuels

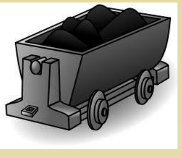
Part (2)

Fossil Fuels

Outlines:

- Fossil fuels-Formation
- Coal-Types-Formation
- Coal resources, production and consumption
- Coal mining technology
- Environmental impacts of coal mining





Fossil Fuels 85% of the world's commercial energy

Natural gas

Coal

Oil

What are Fossil Fuels

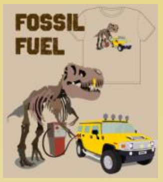
➢ Partially decayed remains of plants, animals and microorganisms

➢ 300 million years ago

• much of earth's climate was mild and warm

– plants grew year round in vast swamps

• as swamp plants and aquatic microorganisms died



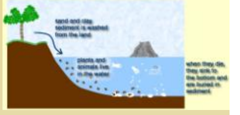
What are Fossil Fuels

Contd....

➢ fell into or sunk in water, decomposed very little due to lack of oxygen

➢heat and pressure that accompanied burial of organic material by sediments

➢ converted decomposed organic material into carbon-rich materials we now call fossil fuels



What are Fossil Fuels

Contd....

➢Industrial societies need a lot of energy and, at the moment, rely on fossil fuels as the main source of this energy.

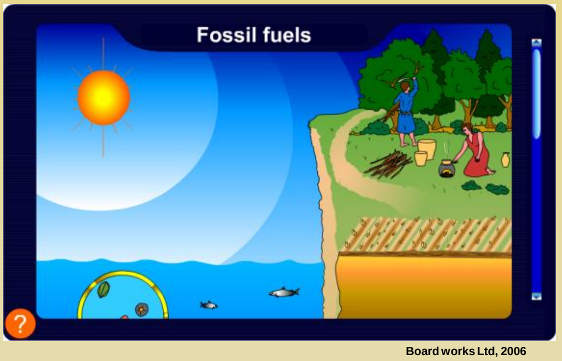
➢ Coal, oil and natural gas are fossil fuels. They are carbon-based materials that formed over millions of years from the remains of ancient plants and animals.

Fossil Fuels

Fossil fuels are so useful because they contain stored chemical energy, which is converted into large amounts of useful heat energy when the fuels are burned.

➢the total amount of fossil fuels available is limited and so

➢ they are classed as non-renewable energy resources

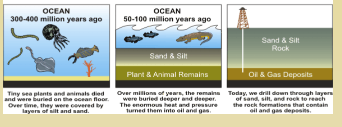


Board works Ltd, 2006

Formation Fossil Fuels

Common conditions

- High Organic Production
- Burial of organic material
- Reducing conditions – little or no free oxygen
- Reducing conditions preserve organic matter



Types of Fossil Fuels

- Petroleum
- Natural Gas
- Coal
- Kerogen (“Oil Shale”)
- Bitumen (“Tar Sands”)

Why do we use fossil fuels

- **why fossil fuels special?**

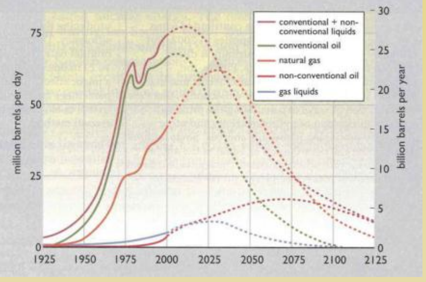
Energy content.

Gasoline: 115,000 BTU/gal = 120 MJoules/gal
Coal: 15,000 BTU/lb = 15 MJoules/lb

Wood: 7,500 BTU/lb = 7.5 MJoules/lb
A “horse” (working 1 hour) = 2.5 MJoules.
A human ... = 0.2 MJoules

Fossil Fuels are ***transportable***.

Declining Fossil Fuels



Forecasts Boyle, *Renewable Energy, Oxford University Press (2004)*

Coal

Coal

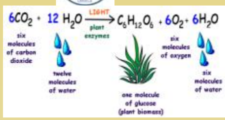
- Solid fossil fuel formed in several stages
- Land plants that lived 300-400 million years ago
- Subjected to intense heat and pressure over many millions of years
- Mostly carbon, small amounts of sulfur

Coal – what do we use it for?

- Stages of coal formation
  - 300 million year old forests
  - peat > lignite > bituminous > anthracite
  - Primarily strip-mined
- Used mostly for generating electricity
  - 62% of the world’s electricity
  - 52% of the U.S. electricity
- Enough coal for about 200-1000 years
  - U.S. has 25% of world’s reserves
- High environmental impact

How coal was formed

About 350 million years ago, trees and other plants **photosynthesized** and stored the Sun's energy.



Dead plants fell into swampy water and the mud prevented them from rotting away.

Over the years, the mud piled up and squashed the plant remains.

After millions of years under this pressure, the mud became rock and the dead plants became **coal**.

Formation of Coal

The formation of coal from dead plant matter requires burial, pressure, heat and time

The process works best under anaerobic conditions (no oxygen) since the reaction with oxygen during decay destroys the organic matter

It is the carbon content of the coal that supplies most of its heating value

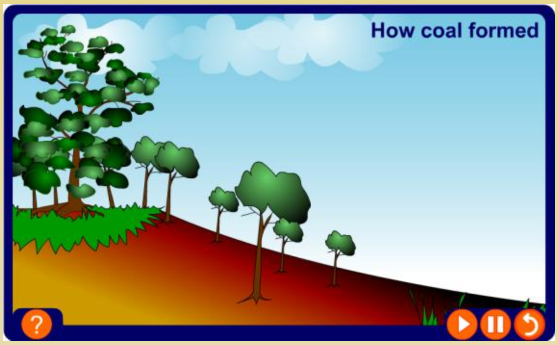
The greater the carbon to oxygen ratio the harder the coal, the more reduced the state of the carbons and the more potential energy it contains

Formation of coal in flow diagram

Dead wood —(bacterial and chemical action)→ Peat —(Δ, Pressure)→ Lignite coal

Lignite coal —(Δ, Pressure)→ Bituminous coal —(Δ, Pressure)→ Anthracite coal

Coal formation



Board works Ltd, 2006

Formation of Coal

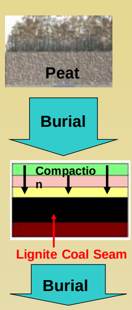
The Formation of Coal Involves Several Steps:

1) Formation of Peat.

- Swamps are areas where organic matter from plants accumulate. As the plants die and get buried they compact to become peat. With time and more compaction, almost all of the water is lost and three different grades of coal result.

2) Formation of Lignite Coal.

- Compaction of the peat due to burial drives off volatile components like water and methane, eventually producing a black-colored, organic-rich coal called *lignite* .



Formation of Coal

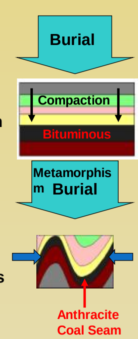
The Formation of Coal Involves Several Steps:

3) Formation of Bituminous Coal.

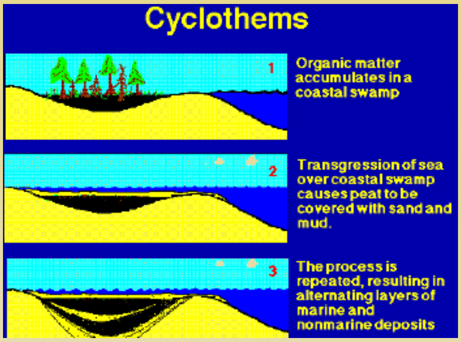
- Further compaction and heating results in a more carbon- rich coal called *bituminous* coal.
- Soft coal which consist of about 85% carbon and burns readily but produces a lot of smoke.

4) Formation of Anthracite Coal.

- If the rock becomes metamorphosed, a high grade coal called *anthracite* is produced.
- Hard dark coal which consist of 90% to 95% carbon and burns very hot and clean. Forms as a result of metamorphic conditions.
- Anthracite coal produces the most energy when burned.



Cycle of Coal Formation



http://earthsci.org

Classification of Coal

The products of coalification are divided into four major categories based on the carbon content of the material

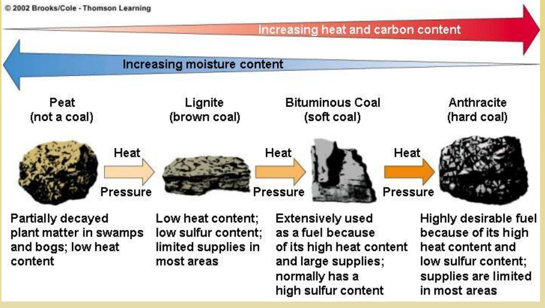

Peat


Lignite


Bituminous

Anthracite

Classification of Coal



Nature of coal formation

exposed during formation to

– higher heat and pressure

» drier (lower water content)

» more compact (harder)

» higher heating value (=higher energy content)

– lower heat and pressure

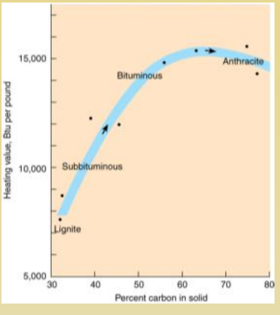
» wetter (higher water content)

» less compact (softer)

» lower heating value (=lower energy content)

Coal types and composition

Fuel Efficiency



As the coals becomes harder, their carbon content increases, and so does the amount of heat released

Anthracite produces twice the energy (BTUs) of lignite

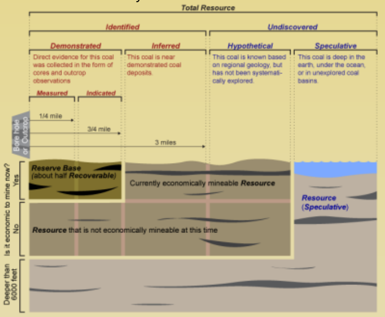
Coal resource, production, consumption

Coal overview

Overview BP website (BP.com)

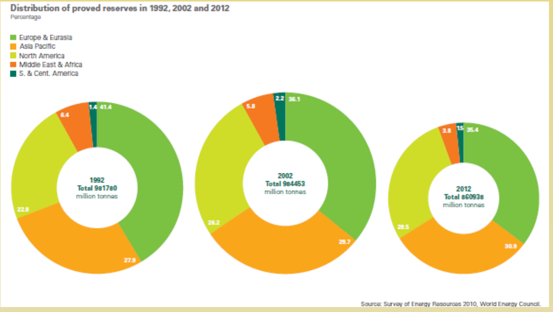
Terminology- Resource and Reserve

Resource : is how much coal is actually in the ground
Reserve: This term refers to coal which is both "demonstrated" (meaning we know it exists) and is deemed to be economically and technologically mineable at any time



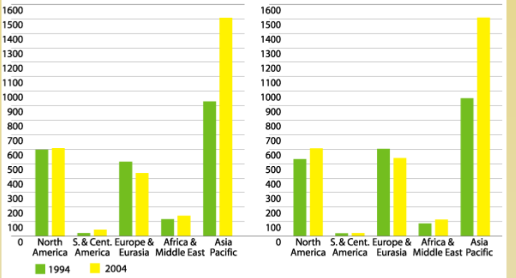
http://www.groundtruthtrekking.org/Issues/AlaskaCoal/CoalTerminology.html

Proved coal reserve at the end of 2004



2004 BP website (BP.com)

Coal production-Coal consumption



Coal consumption and production experienced another robust year in 2004, although growth moderated from the very strong rates seen in 2003 as prices rose. Growth was strongest in the Asia Pacific region, with China alone accounting for nearly 75% of global consumption growth.

2004BP website (BP.com)

Coal Mining

Strip Mining **Subsurface Mining**

Coal Mine

Coal occur in seams or beds
Thickness from inches to more than 100 ft

Two types of mining e.g.

Strip (60%) and sub-surface

Strip: removed overburden rock and placed aside

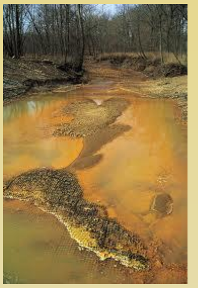
Disadvantage of strip mining: erosion, acid mine drainage, hazardous to surrounding vegetation and aquatic life

Environmental Concerns

- Acid Mine Drainage
- Acid rain
- Increasing atmospheric CO_2
- subsidence
- Coal seam fires

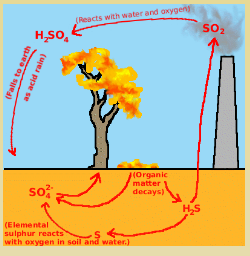
Acid Mine Drainage

- Sulphur in the exposed coal combine with oxygen and water vapor to form sulfuric acid (H_2SO_4)
- This acidic water is harmful to vegetation and aquatic life.

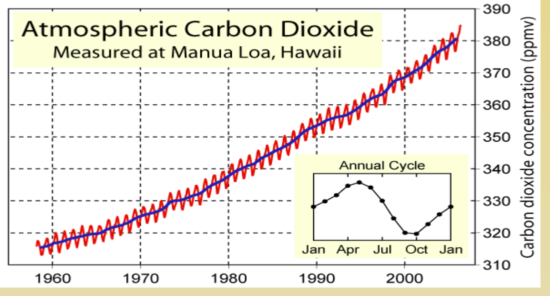


Acid Rain

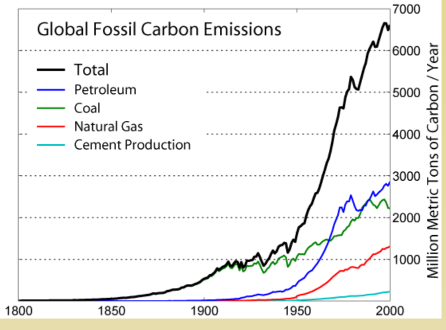
- From burning of coal releases SO_2.
- There are 1 to 2% S



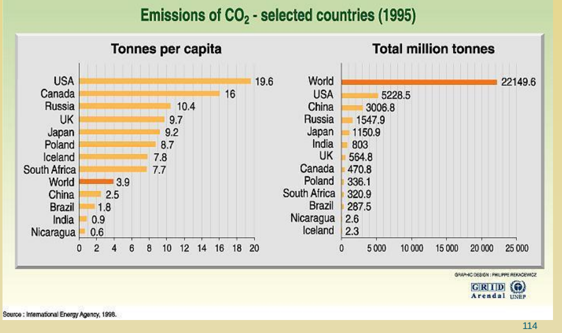
Increasing Carbon Dioxide



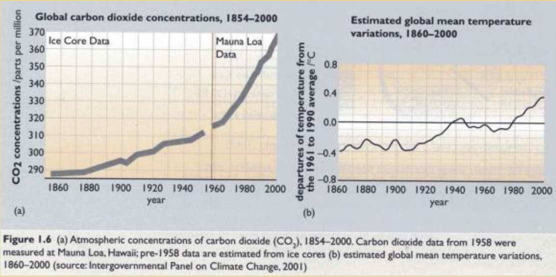
Global Fossil Carbon Emission



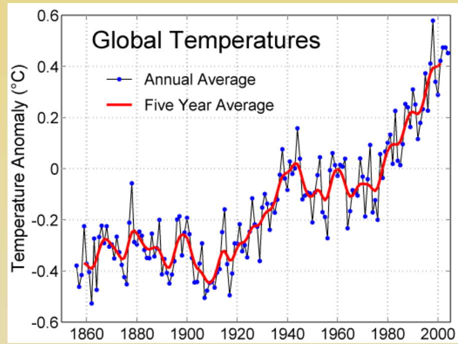
Emission of Carbon Dioxide



Carbon Dioxide & Mean Temp.



Global temp.



Subsidence and Coal Seam Fires

Subsidence **Coal Seam Fire**

How do fossil fuels produce electricity?

Power stations that are fuelled by coal and oil, operate on the same basic principle.

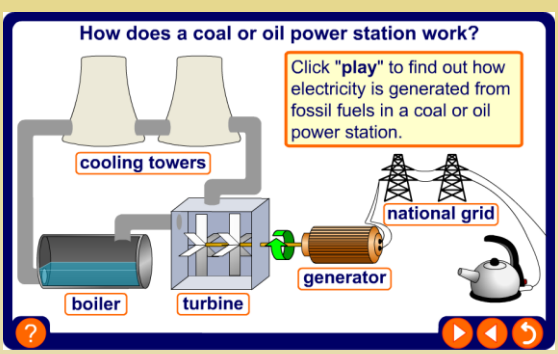
The fuel is burned and the heat produced is used to boil water. This creates high-pressure, superheated steam, which is then used to turn a turbine.

The turbine turns a generator and so generates electricity.

The cooling towers cool the steam, which condenses as water and can then be recycled in the power station.

Natural-gas-fired power stations do not use steam. The natural gas is burnt and the hot gases produced are used directly to turn the turbine.

What happen in a coal station



Energy Conversion