Natural Resources
PART II

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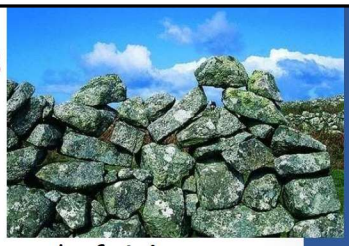
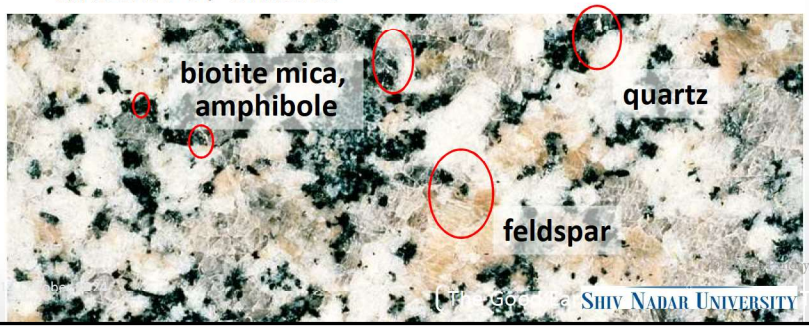
Rocks, Minerals and elements



Rocks are made of minerals

- ~20 common minerals
- Example: The rock **granite** is composed of **4 key minerals** –
  - ***feldspar, quartz, mica, amphibole*** - and minor amounts of others.



Rocks, Minerals and elements

Rock is an aggregate of one or more minerals.

Minerals are made of elements

- Some minerals (e.g., quartz) are composed of just two elements
- Others (e.g., amphibole) are made up of several elements
- Some elements occur more frequently than others. i.e. Silicon, Oxygen…

Mineral	Elements
Quartz	Oxygen, silicon
Feldspar	Oxygen, silicon, aluminum, calcium, sodium, potassium
Mica	Oxygen, silicon, aluminum, iron, potassium, magnesium
Amphibole	Oxygen, silicon, aluminum, iron, calcium, magnesium

Rocks, Minerals and elements

Minerals are made of elements

- 8 common elements compose 98% of continental crust rocks
- Si + Al

Element	Ion	Percent by weight	Also found in
Oxygen (O)	O^{2-}	46.6	Air
Silicon (Si)	Si^{4+}	27.7	Window glass, computer chips
Aluminum (Al)	Al^{3+}	8.1	Cans, aircraft
Iron (Fe)	Fe^{2+}, Fe^{3+}	5.0	Meat, cornflakes, your car
Calcium (Ca)	Ca^{2+}	3.6	Milk, cheese, cement, antacids
Sodium (Na)	Na^{+}	2.8	Salt, bacon, cheese
Potassium (K)	K^{+}	2.6	Fish, fruit, nuts, fertilizer
Magnesium (Mg)	Mg^{2+}	2.1	Bread, nuts, salt
Other	–	1.5	–

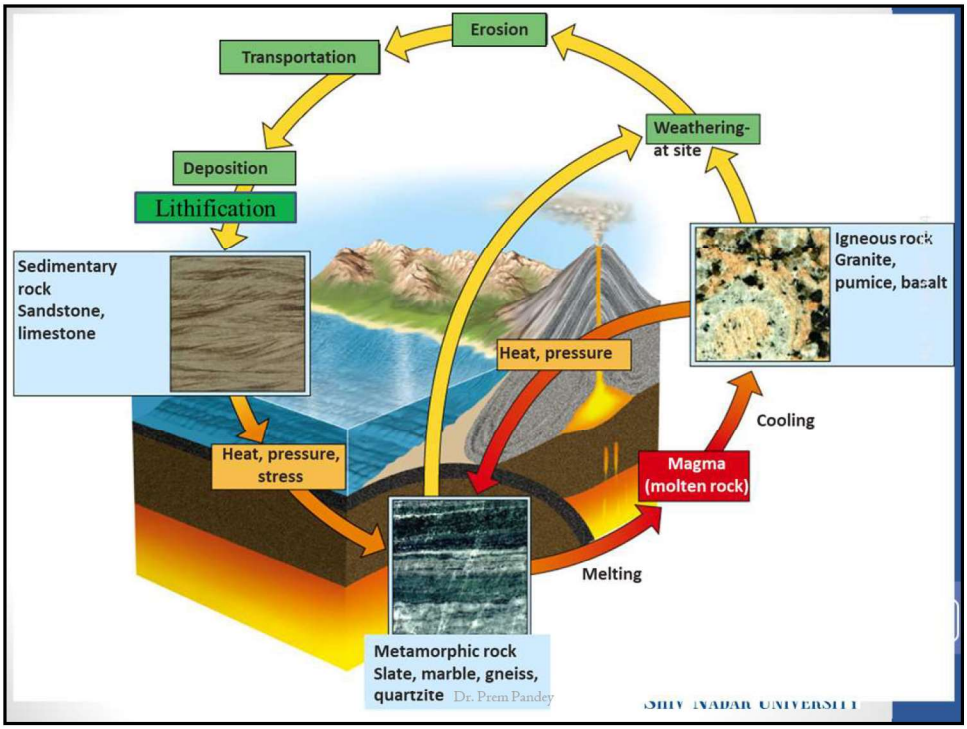
Types of Rock

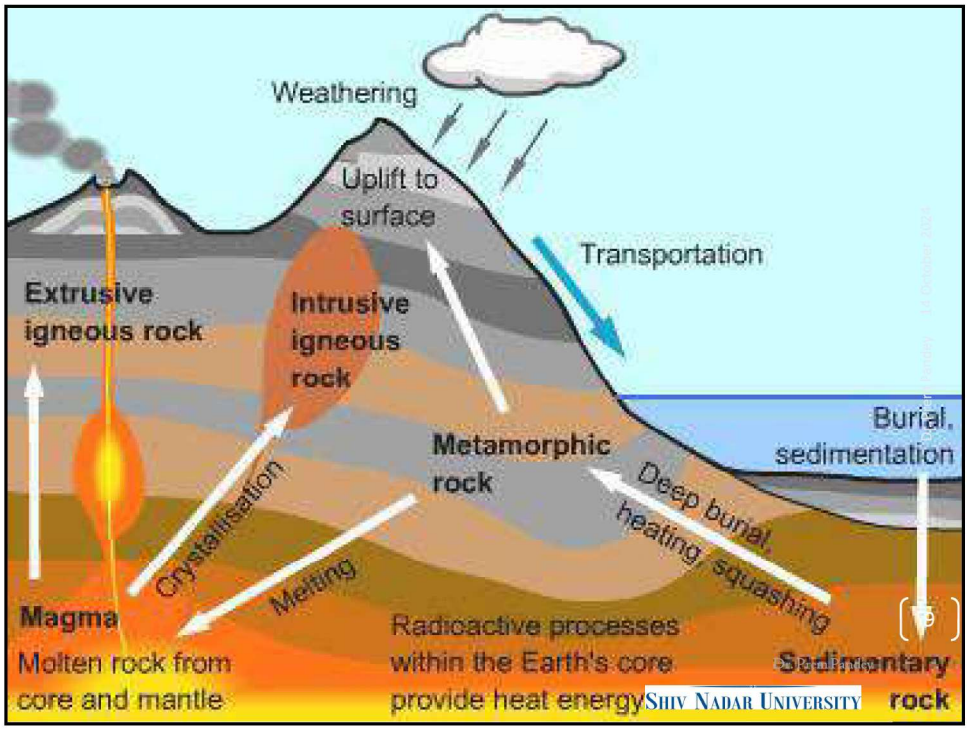
Geologists classify rocks in three groups, according to the major Earth processes that formed them. These are

(i) Igneous,

(ii) Sedimentary, and

(iii) Metamorphic rocks.





Minerals in ROCKS

Quartz- most common crystalline form of SI02- second most abundant mineral in earth crust after feldspar.

- Acid and intermediate igneous rocks- &
- many metamorphic , and
- terrigenous sedimentary rocks

Minerals Most Commonly Found in the Three Rock Families

Rock Family	Common Minerals
Igneous	Feldspar, quartz, olivine, amphibole, pyroxene, mica, magnetite
Sedimentary	Clay, chlorite, quartz, calcite, dolomite, gypsum, goethite, hematite
Metamorphic	Feldspar, quartz, mica, chlorite, garnet, amphibole, pyroxene, magnetite

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10

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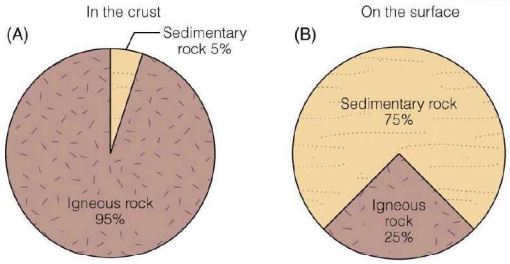
Rocks

- Earth's crust is mainly Igneous rocks mainly,
- However, most of the rock we see at surface is Sedimentary, especially in Himalayas



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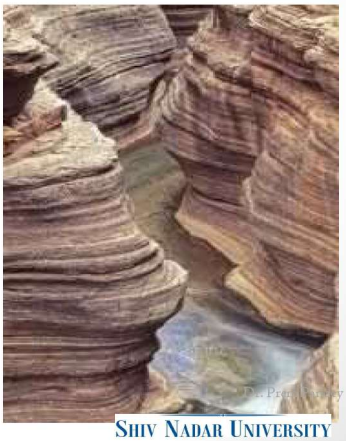
I. Sedimentary rocks

- Sedimentary rocks are types of rock that are formed by the deposition of material at the Earth's surface and within bodies of water.



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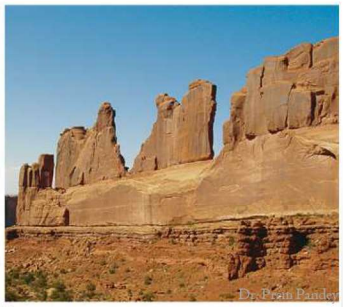
Sedimentary Rocks

Sedimentary rocks form as horizontal layers (beds)

- identified based on composition, thickness
- oldest beds at bottom, youngest at top

a.



b.

Sedimentary Rocks

Three types of sedimentary rocks

- Clastic, Chemical, Biochemical
  - Identified by materials that make up the rock and/or the process by which they formed

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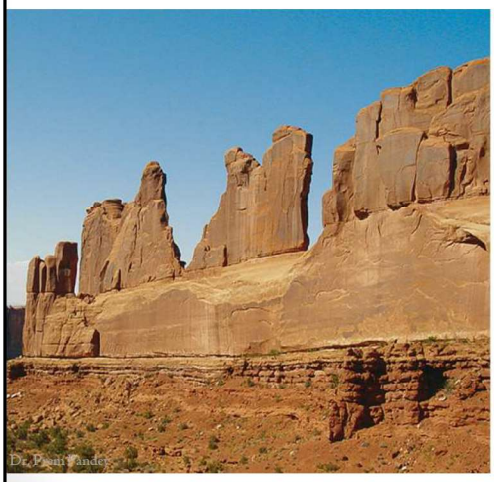
d

Sedimentary Rocks

1. Clastic Sedimentary Rocks



- Composed of rock and mineral fragments
  - Most common type of sedimentary rock
- 3 stages of formation
  - Generation
  - Transportation
  - Lithification

Sedimentary Rocks

2. Chemical Sedimentary Rocks

Salt deposited on floor of Lake.

- Form when minerals precipitate (crystallize) from a solution as a result of changing physical conditions
  - Solutions = fresh water in lakes, groundwater or seawater
  - Changing conditions commonly = increased temperatures (evaporation)
- Can be readily dissolved in water and transported to oceans
- Rocks are typically indicative of shallow, coastal marine conditions in geologic past
  - Termed evaporates as most form by precipitation due to evaporation

Sedimentary Rocks

3. Biochemical Sedimentary Rocks

a.

- Link the biosphere and geosphere
- Form due to actions of living organisms that cause minerals to be extracted from solution

The mineral calcite is present in the rock limestone formed by coral organisms that build tropical reefs

OR

- From the remains of dead organisms

Coquina → limestone formed from broken shell fragments

Coal → carbon-rich rock formed from compacted plant remains

2. Metamorphic rocks

Metamorphic rocks arise from the transformation of existing rock types, in a process called metamorphism, which means "change in form".

Metamorphic rocks

The original rock (protolith) is subjected to heat (temperatures greater than 150 to 200 °C) and pressure (1500 bars), causing profound physical and/or chemical change.

The protolith may be a sedimentary rock, an igneous rock or another older metamorphic rock.

Metamorphic rocks make up a large part of the Earth's crust and are classified by texture and chemical and mineral assemblage (metamorphic facies).

Metamorphic Rocks

Metamorphism

- Changes in mineral composition and texture that can occur in any solid rock
- Changes due to increasing temperature and/or pressure and/or the presence of fluids.
  - Temperatures high enough to promote chemical reactions but not high enough to cause melting
    - Approximately 200°C → 1100°C, depending on rock type and conditions
    - Similar temperatures found deep in crust or near magma chambers

3. Igneous rock

Igneous rock (derived from the LATIN word *ignis* meaning fire), is formed through the cooling and solidification of magma or lava.

Granite, basalt, and obsidian are examples of igneous rocks.

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Igneous rock

Igneous rock may form with or without crystllization,

- *either below the surface as intrusive (plutonic) rocks or*
- *on the surface as extrusive (volcanic) rocks.*

This magma can be derived from partial melts of existing rocks in either a planet's mantle or crust.

Typically, the melting is caused by one or more of three processes:

- *an increase in temperature,*
- *a decrease in pressure, or*
- *a change in composition.*

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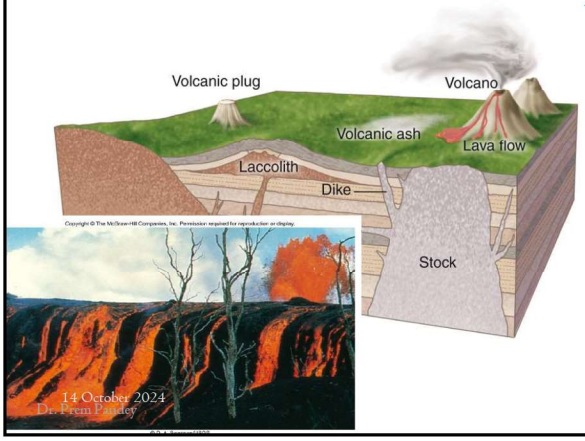
Igneous Rocks

Two types of igneous rocks are classified based on texture and composition

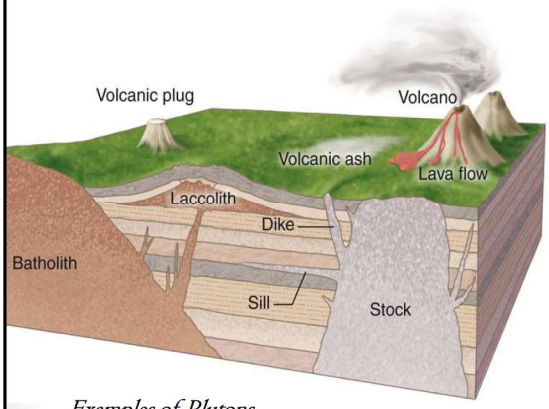
The same magma can form both rock types



1. Volcanic rocks – form when magma rises to Earth's surface
   - Produces from volcanoes, lava flows, tephra
   - Molten rock cools rapidly

Igneous Rocks

2. Plutonic rocks – form when magma solidifies below Earth's surface
   - Produces plutons that remain hidden until exposed by erosion
   - Molten rock cools slowly.
   - Slow cooling produces large, visible crystals



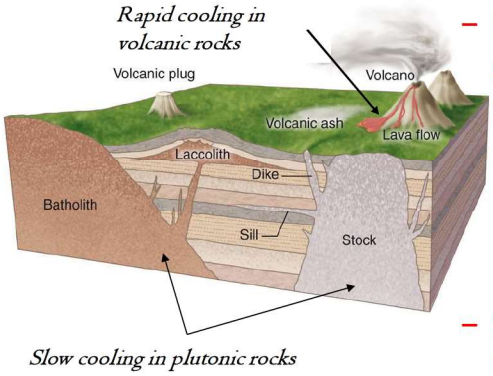
Examples of Plutons

Batholith, stock, sill, dike, laccolith

Igneous Rocks

Texture

- Size of crystals of minerals in igneous rocks depends on rate of cooling of magma
  - Rapid cooling produces microscopic crystal, smaller crystals
    - Brittleness: Rapid cooling can make crystals more brittle or soft than crystals that cool slowly.
  - Slow cooling produces large, visible crystals (~~volcanic~~ plutonic rocks)
- Crystal size interpreted to learn where rocks formed

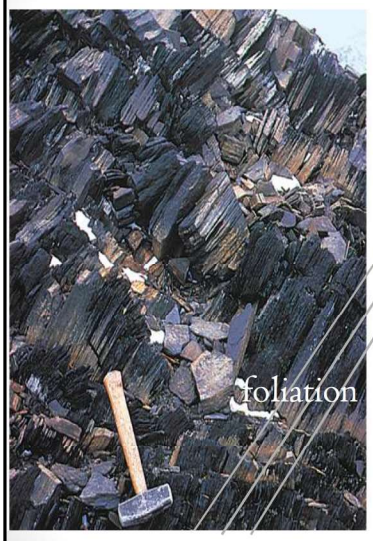


Igneous Rocks

Color

- Color varies with silica content (composition)
  - Silica-rich minerals such as quartz and feldspar are light-colored
  - Silica-poor minerals such as amphibole, biotite mica are dark colored

Metamorphic Rocks



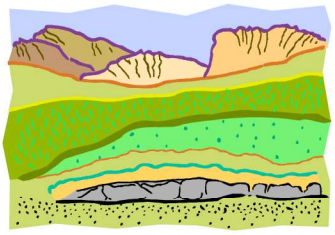
Increased pressures and temperatures cause tabular minerals to take on a preferred orientation, foliation, perpendicular to direction of pressure

Comparison

Un-metamorphosed, non-foliated original rock (granite- igneous roc) with random distribution of minerals

Metamorphic rock (gneiss) with foliation illustrates parallel alignment of minerals

Land and Soil



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Regolith and soil

- Regolith is a layer of loose, heterogeneous superficial material covering solid rock.
- It includes dust, soil, broken rock, and other related materials and is present on Earth, the Moon, Mars, some asteroids, and other terrestrial planets and moons.

MARS

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30

Soils: An Introduction

Soil is a mixture of fine powdered rocks, organic matter, liquids, myriad organisms and other minerals.

Soil: a stratified mixture of regolith that includes enough organic material, water, and air to support plant life

- Organic material is supplied by decaying/decomposition of plants and animals
- Organics get mixed with soil by burrowing animals, worms, and insects
- Water moves through the soil and leaches it (dissolves iron) thorugh spac
- Water can transport fine clay particles to lower layers

SOIL

Soil is one of the major natural resources, like air and water.

It is the topmost layer of the earth's crust.

It acts as an interface between hydrosphere, lithosphere, earth's atmosphere and biosphere.

SOIL

- The proportion of the key ingredients determines the type of soil.
- But, factors such as vegetation, climatic conditions, human activities for e.g. grazing, farming etc also influence soil formation.

Soils

- Soil formation is controlled by
  - The rock in the source area
  - Temperature and amount of rain in a region (climate factors)
  - Biological activity occurring in an area

Soil may take thousands of years to develop due to slow rates of chemical weathering.

In warm, wet climates soils may develop in a few hundred years owing to rapid chemical weathering.

The thickest soils exist in tropical regions that have year-round warm temperatures and rainfall.

Soils

- Soil fertility – thick soil is not necessarily fertile soil
  - Fertility changes over time depending on leaching and replacement of nutrients by weathering
  - Heavy rainfall can carry away soil nutrients

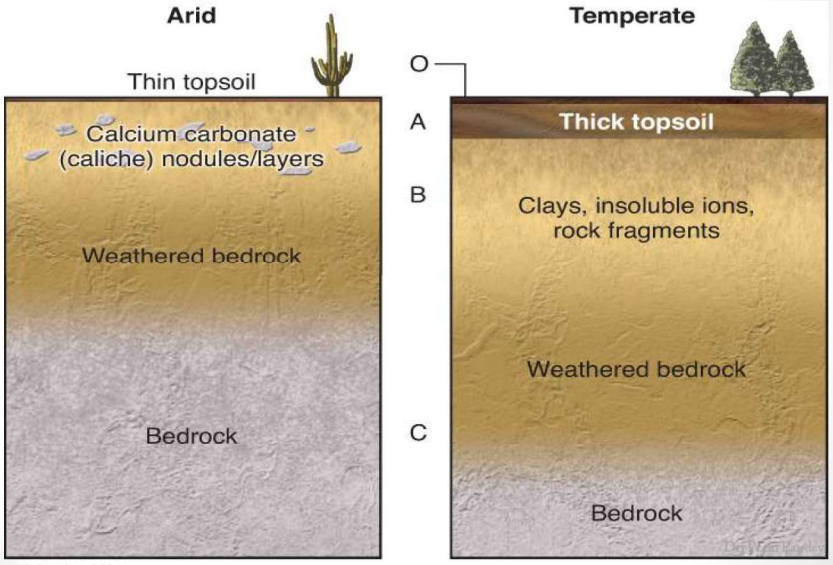
  Example: rainforests have dense vegetation but the extreme rainfall carries nutrients away, leaving only the top few centimeters of soil fertile.

There are different soil types based on the texture and composition of the soil.

Soil Profiles

- *Soil Profile*: A series of distinct soil horizons (horizontal layers) created by
- 1. Organic Activity
- 2. Leaching and Precipitation
- 3. Transport of Clays

Affect of climate on soil profiles



Soils

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Soils profiles from different areas

What do you notice about them? Why do you think they look different?

Soils

Characteristics of soil profile:

O – Organic debris, dead leaves, plant and animal remains make up 30% of this layer. Usually at top. Why? Fine particles.

A – Topsoil, dark organics mixed with mineral grains by organic activity. Lacking in fine particles and soluble ions.

E – Zone of Leaching or Subsurface layers that have lost most of their minerals. Can be embedded in A horizon or replace A horizon.

B – Subsoil: Ions leached from A are precipitated here. Includes clay particles that were carried down from A. Little organic material is present. Red color due to oxidation (rainy areas), or accumulation of calcium carbonate (arid areas) forming a white layer.

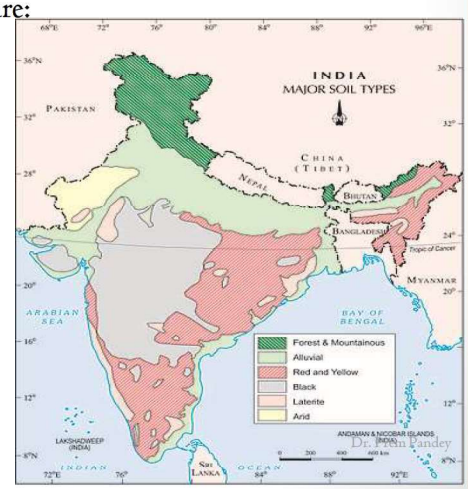
C – Weathered: Lowest layer, consists of soil parent material, either weathered bedrock (regolith) or unconsolidated sediments

SOIL

In India, various types of soils are found and their formations are influenced by certain factors such as altitude, climate disproportionate rainfall and many others.

The type of soil differs in different areas of the country. The major types of soils found in India are:

1. Black Soil
2. Laterite Soil
3. Red Soil
4. Desert Soil
5. Mountain Soil
6. Saline and Alkaline Soil
7. Peaty and Marshy Soil
8. Alluvial Soil



BLACK SOIL

I. Black Soil

This type of soil is made up of volcanic rocks and lava. Black soil is also known as 'regur' which is derived from a Telugu word 'reguda'.

Black soil is also known as Black Cotton Soil as cotton is an important crop which is grown in this type of soil.

- **Rich in:** Iron, lime, calcium, potassium, aluminum, and magnesium.
- **Deficient in:** poor in Nitrogen, phosphorus, and organic matter.
- **Color:** Deep black to light black.
- **Texture:** Clayey.

High water retaining capacity.

- Swells and will become sticky when wet and shrink when dried.
- **Self-plowing** is a characteristic of black soil as it develops wide cracks when dried.

It is mostly found in areas such as Gujarat, Madhya Pradesh and Maharashtra. It is also found in states like Tamil Nadu, Andhra Pradesh and Karnataka.

Laterite Soil

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2. Laterite Soil

Laterite Brick Soil

Laterite Soil: The laterite soil is found in those regions of the country which receive heavy rainfall with alternate dry and wet period (high temperature)

The Latin word 'Later' which means Brick.

In these climatic conditions, leaching of soil takes place which is a process in which fertile portion of the soil gets washed away by heavy rains.

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Laterite Soil

They are formed from the decomposition of rocks and contain iron oxide which gives them red or pink colour.

- humus content is low.
- **Rich in**: Iron and Aluminum
- **Deficient in**: Nitrogen, Potash, Potassium, Lime, Humus
- **Color**: Red color due to iron oxide.

This type of soil is normally deficient in nitrogen and is poor in lime content.

This type of soil is found in several parts of the country mainly Western and Eastern Ghats, Vindhyas, Malwa plateau and Satpuras. The states where this type of soil can be found are Kerala, West Bengal, Andhra Pradesh, Bihar, Meghalaya, Assam, Odisha to name a few.

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3. Red Soil

This type of soil is formed as a result of weathering of metamorphic and igneous rocks.

The red colour of the soil comes from the high percentage of iron content.

The soil's texture varies from being sandy to clayey, but it is mainly loamy.

- Absence of lime, kankar (impure calcium carbonate).
- **Deficient in**: lime, phosphate, manganese, nitrogen, humus, and potash.
- **Color:** Red because of Ferric oxide. The lower layer is reddish-yellow or yellow.
- **Texture:** Sandy to clay and loamy.

Thus, it is rich in potash content but lacks phosphate, humus and nitrogen content.

The red soil is found in regions such as Tamil Nadu, Madhya Pradesh, Jharkhand, Odisha, some parts of Karnataka and southeast Maharashtra.

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Desert Soil

4. Desert Soil

The desert soil is found in regions with low rainfall. The sand in the desert areas is partly original and partly blown from Indus Valley.

- Deposited mainly by wind activities.
- High salt content.
- Lack of moisture and Humus.
- Kankar or Impure Calcium carbonate content is high which restricts the infiltration of water.
- Nitrogen is insufficient and Phosphate is normal/ high.
- **Texture:** Sandy -The soil content 90-95% of sand & 5-10% of clay.
- **Color:** Red to Brown.

The phosphate content in the soil is high while the nitrogen content is low.

The water content in the soil is fulfilled through irrigation.

This type of soil is found in arid and semi-arid areas. Desert soil is found mostly in areas of Rajasthan, and also in Haryana and Punjab.

Mountain Soil

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5. Mountain Soils

Mountain soils are formed due to the accumulation of organic matter which is derived from the forest growth.

- Immature soil with low humus and acidic.
- Mountain soils are found in hilly and mountainous regions, including the Himalayas.
- They are highly weathered and can vary in composition depending on local conditions.

This type of soil is rich in humus but has poor lime, potash and phosphorus content. It is generally sandy and has gravels.

It is mainly found in Himalayan region of the country. Maize, barley, wheat and temperate fruits are grown in this soil in the Himalayan region. Plantation of crops like tropical fruits, coffee, tea or spices in states of south India like Kerala, Tamil Nadu and Karnataka are undertaken in this type of soil.

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Saline and Alkaline Soil

Saline & Alkaline soil

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6. Saline and Alkaline Soil

SALINE & ALKALINE SOIL Contains salts like Sodium, Magnesium, Calcium. Infertile, unfit for cultivation. Sandy to loamy in texture. Areas: Parts of Gujarat, Rajasthan, Punjab, Haryana, U.P & Maharashtra.

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Nature of Saline and Alkaline Soil

The presence of an excess of sodium salts and the predominance of sodium in the exchangeable complex are divided into the two main groups:

- (1) Saline soils and
- (2) Alkaline soils.

(1) Saline Soils:

Saline soils contain an excess of sodium salts, but its colloidal material is not yet sodiumised.

(2) Alkaline Soils:

- In the case of alkali soils, the exchange complex contains appreciable quantities of exchangeable sodium. Such soils may or may not contain excess salts.
- These soils can be reclaimed for agriculture through drainage and soil amendments.

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Saline and Alkaline Soil in Punjab

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Formation of Saline and Alkaline Soil

Origin or development of saline and alkaline soil depends upon following factors:

- (i) Arid and Semi-Arid Climate:
- (ii) Poor Drainage of Soil:
- (iii) High Water Table:
- (iv) Overflow of Sea Water over Lands:
- (v) Introduction of Irrigation Water:
- (vi) Salts Blown by Wind:
- (vii) Saline Nature of Parent Rock Materials:
- (viii) Excessive Use of Basic Fertilizers:
- (ix) Humid and Semi-Humid Regions:

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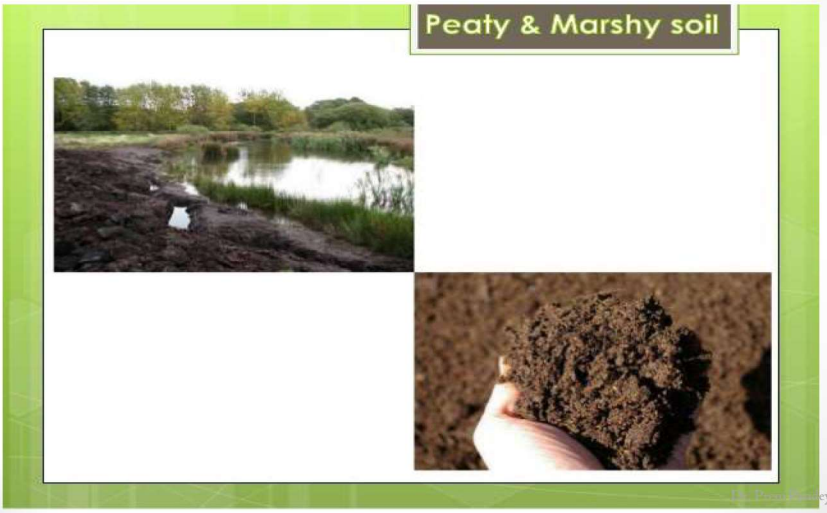
Peaty and Marshy Soil



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6. Peat Soil

Accumulation of high amount of organic matters in the soil in humid regions results in the formation of peaty soils.

These types of soils constitute about 10 to 40% of the organic matter and also a reasonable amount of soluble salts.

- Areas of heavy rainfall and high humidity/ vegetation growth low

Peaty soils are heavy, black in colour high organic contents and have high acidic content.

- A large quantity of dead organic matter/humus which makes the soil alkaline.
- Found in areas with *high water tables*
- They are low in phosphate and potash content.

Peaty and marshy soils are found in a few districts of Kerala.

On the other hand, marshy soils are found in coastal areas of some states such as Tamil Nadu, Bihar, Almora district of Uttaranchal and Sunderbans of West Bengal.

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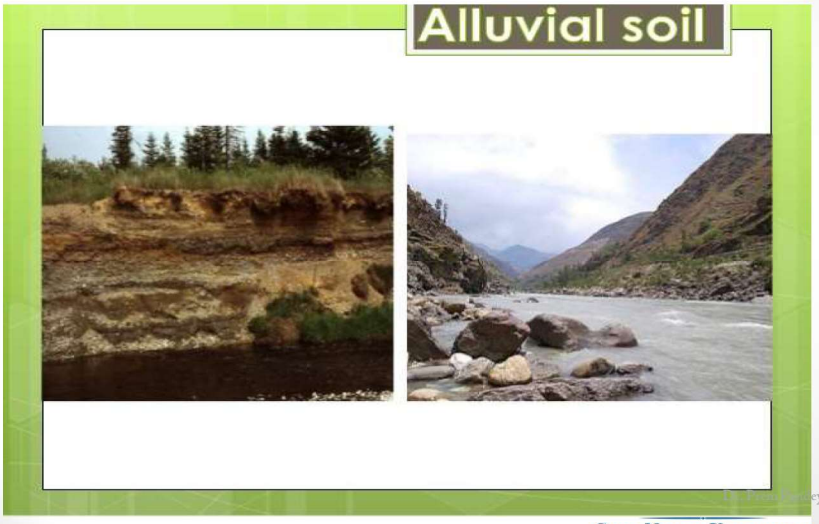
60

Alluvial Soil



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61

7. Alluvial Soil

Alluvial soils are formed by the deposits of the sediments brought by rivers.

Most of the rivers originate from the Himalayas and bring along high amount of sediments with them.

- The soil is made up of particles like silt, sand and clay.
- Rich in Nitrogen, rich in potash and lime.
- It has adequate amount of phosphoric acid,

Alluvial soil is of two types –

(i) old alluvium known as Bangar, and

(ii) new alluvium called Khaddar.

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Alluvial Soil

The alluvial soil is spread all over the plains of north India.

They are also found in the four delta regions of the south.

(the Kaveri, the Godavari Mahanadi and the Krishna)

Strips of alluvium occur along rivers in the plateau as well as in the mountains.

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63

Alluvial Soil

Alluviums are mainly loams, i.e. mixtures of sand and clay.

New alluvial loams are very fertile.

In the younger stage of the riverine plains, sandy soils are more common. While in the beds of the rivers, it consists generally of pure sands.

These soils cannot retain water.

'Zaid*' types of crops grow here, such as watermelons, muskmelon, cucumber, etc.

(* in between Rabi & Kharif crop seasons, there is a short season during summer months)

Near the river mouths, the soil is usually clay.

It retains water but does not allow root growth.

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Alluvial Soil

It is the most important type of soil found in the country as it covers about 40% of the total land. It is found in the areas of northern plains beginning from Punjab to West Bengal and Assam.

It is also found in deltas of different rivers such as Krishna, Godavari, Kaveri and Mahanadi in peninsular India.

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65

Unit 2: Natural Resources

- Introduction, types of natural resources
- Non-renewable resources
- Renewable resources
- Minerals
- Energy
- Role of an individual in conservation of natural resources
- Energy in India: an overview

What is Energy?

- Energy is the capacity to
  - Do work
  - Move matter
  - Make things happen
- Energy exists in many different forms
- The sum of the different kinds of energy in a system is the internal energy

What is Energy?

- To change the internal energy of a system, energy must be added or taken away
- This is called work
- Energy can take lots of different forms, but all are described as either
- Potential Energy
  - Energy that is stored in a system
- Kinetic Energy
  - Energy that is expressed in movement
- Or a combination of these

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68

What is Energy?

- Kinetic energy, energy that is expressed in the movement of electrons, atoms, molecules, materials, and objects, includes
  - Radiant energy
  - Electrical energy
  - Thermal energy (heat)
  - Sound
  - Motion

Kinetic energy is energy of motion.

A rock sitting at the edge of a cliff has potential energy. If the rock falls, the potential energy will be converted to kinetic energy.

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70

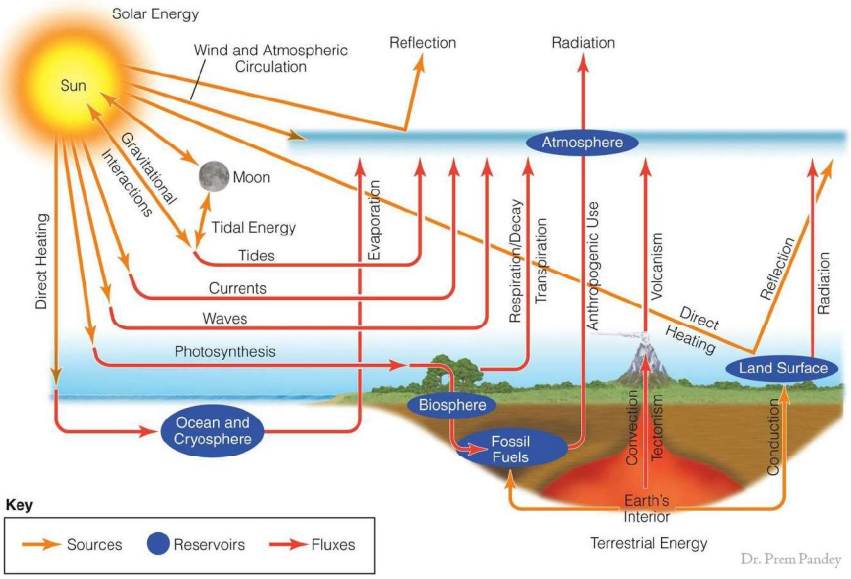
External Energy Sources

- All processes in the Earth system are driven by energy
- External energy sources are
  - The sun
  - Gravity and tides

Energy resources

- Earth's energy comes from three sources
  - Solar radiation
  - Geothermal energy
- Circulates through the pathways and reservoirs of Earth's energy cycle,
- All energy for human use is derived from the circulating energy in this cycle such as Tidal energy

Energy resources



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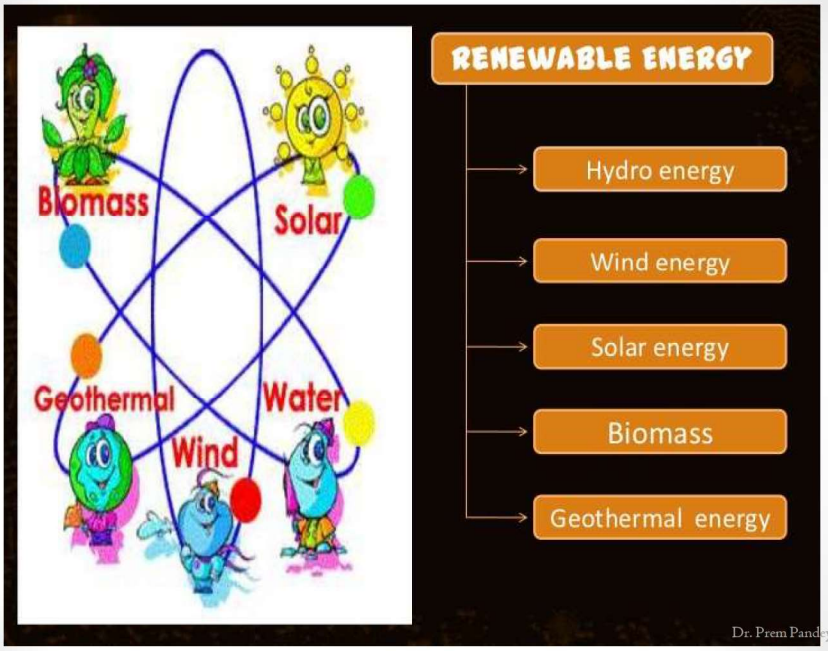

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External Energy Sources

Solar Energy

- The Sun is responsible for 99.985% of all external energy in the Earth system,

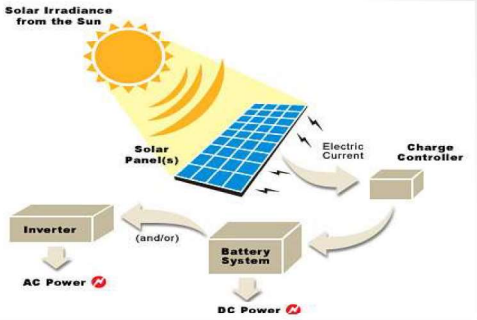
But external energy also comes in as a result of gravity: the mutual physical attraction between the Earth and the Moon

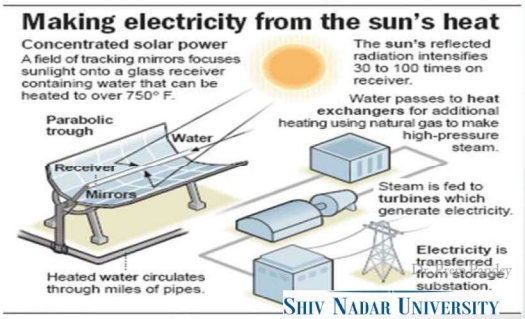
- The Sun is a star that radiates heat as a result of thermonuclear reactions (fusion) in its core

External Energy Sources

- Fusion converts matter to energy
- Energy released by fusion in the Sun is in the form of gamma rays (98%) and neutrons
- Gamma rays are responsible for the tiny fraction of the Sun's energy that reaches the Earth
- As gamma rays move outward from the core they are repeatedly absorbed and reemitted as longer-wavelength and lower-energy radiation.

Solar energy and uses





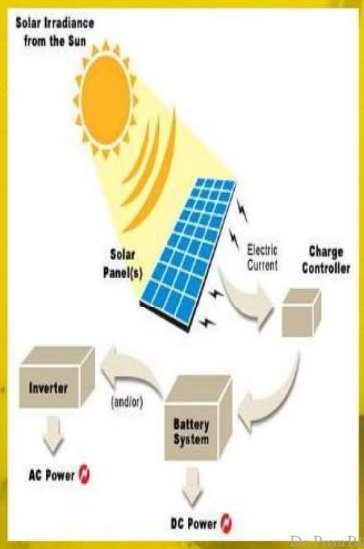
Solar energy

- **Solar energy** is the radiant light and heat from the sun.
- It has been harnessed by humans since ancient times using a range of ever-evolving technologies.

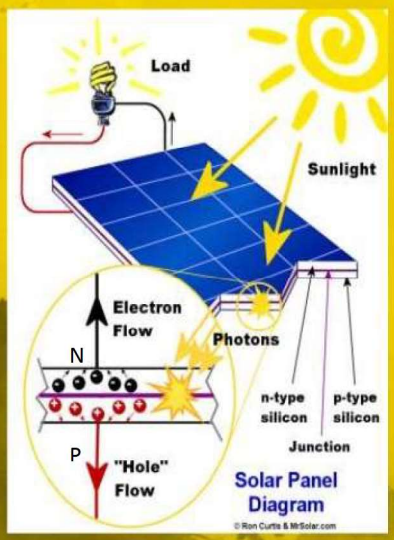
Solar energy technologies include use of solar energy for

- solar heating
- solar photovoltaic
- solar thermal electricity
- solar architecture

- We can change the sunlight directly into electricity by using solar cells also called as ***photovoltaic cells***



How electricity is generated?



- When sunlight strikes the solar cell electrons are knocked out loose from the molecule
- They move towards the treated front surface.
- An electron imbalance is created between both the surfaces of the solar cell.
- When the two surfaces are joined by a connector like a wire , a current of electricity occurs between the negative and positive sides.
- This electricity produced s used for various purposes household and industrially.
- Use of many solar cells or setting a solar plant provides the purpose.

Internal Energy Sources

Hydro-energy/Hydro-power

Hydro-energy is cheap and clean.

The water falls under the force of gravity and is dynamic-kinetic energy is transformed to mechanical energy that is used exclusively for generation of electric power by using hydraulic turbines.

It needs continuous availability of water.

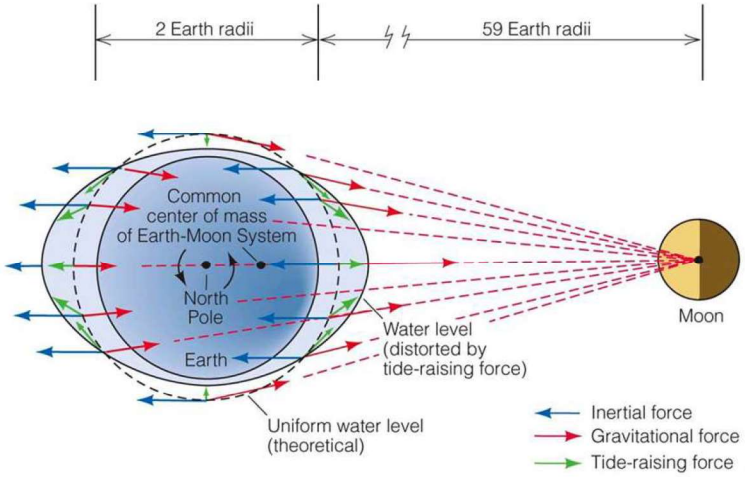
Mega-dams destroy ecosystems and biodiversity.

External Energy Sources

Tidal Energy

- External energy also comes in as a result of gravity: the mutual physical attraction between the Earth and the Moon
- The gravitational pull that the Moon exerts on Earth is balanced by an equal and opposite inertial force created by Earth's movement
- The side of Earth nearest to the Moon is pulled toward the Moon by gravity while the side of Earth farthest from the Moon is pulled away by inertial force
- This produces a periodic distortion called a tide, which takes the form of a flattening distortion (ellipsoid)

Internal Energy Sources



Internal Energy Sources

Tidal-energy

Rhythmic, twice-daily rise and fall of ocean water along coastlines

Generates tidal bulges due to gravitational pull and inertial force

- Highest and lowest tides when sun and moon are aligned
- Least tidal range when sun and moon are not aligned

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Internal Energy Sources

- Tidal-energy

Tides can be used to produce electric power known as tidal power. The use of tides is possibly only in a few sites where geography of an inlet or bay favors the construction of an hydroelectric plant.

Tidal energy in India (150 MW) was first attempted near TVM.

Major tidal project is proposed in the gulf of Kutch in Gujarat.

Others is gulf of Cambay and in west Bengal.

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Internal Energy Sources

- Wave-energy
  - Also an indirect expression of solar energy
  - Small-scale power stations produce electricity using a hollow, tubelike chamber containing a turbine
  - Waves push air into the chamber, spinning the turbine, generating electricity

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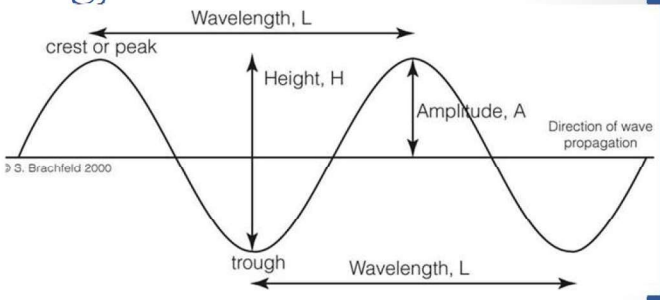
Internal Energy Sources

- Wave-energy



- Surface waves receive their energy from wind:
  - The size of a wave is determined by wind speed, duration, and fetch (distance)
  - Important wave dimensions are the height (from crest to trough) and wavelength (from crest to crest or crest to trough)
  - As depth decreases, the wave's shape is distorted;
  - height increases, wavelength shortens, and the wave front grows steeper, eventually collapsing (breaking)

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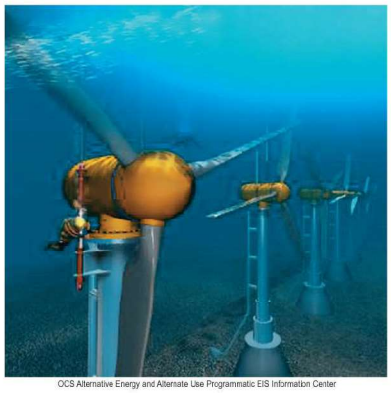
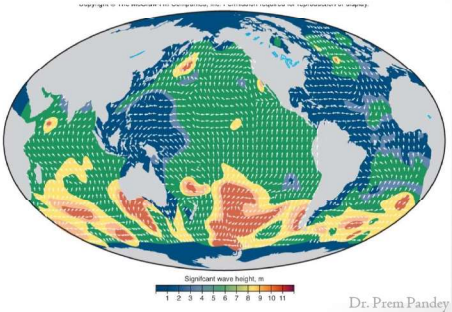
Wave Action: Turning waves into energy



OCS Alternative Energy and Alternate Use Programmatic EIS Information Center

- Ocean waves are actually energy moving through the oceans
- If that energy could be harnessed, it would be clean and renewable



Wind Energy

Wind Energy

History

- Humans have been using wind power for at least 5,500 years to propel sailboats and sailing ships.
- Windmills have been used for irrigation pumping and for milling grain since the 7th century AD in Afghanistan, India, Iran and Pakistan.

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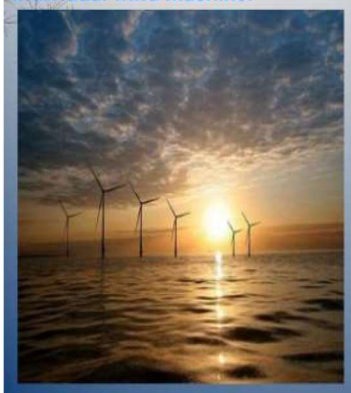
Wind power is a renewable energy source used to generate electricity by converting wind energy into mechanical energy. This mechanical energy is then converted into electricity by the use of an electrical generator located within each individual wind machine.



Off –shore wind turbine

- Blowing wind spins the blades of a wind turbine – this device is called a wind turbine and not a windmill
- A windmill grinds or mills grains or is used to pump water
- Worldwide there are now many thousands of wind turbines operating, with a total nameplate capacity of 194,400 MW.
- World wind generation capacity more than quadrupled between 2000 and 2006, doubling about every three years.

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Electricity generation

- The blades of a turbine are attached to a hub that is mounted on a turning shaft.
- The shaft goes through a gear transmission box where the turning speed is increased.
- The transmission box is attached to a high speed shaft which turns a generator that makes electricity
- In a wind farm(which is a group of wind turbines in the same location used for production of electric power), individual turbines are interconnected with a medium voltage (often 34.5 kV), power collection system and communications network.

wind farm

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Internal Energy Sources

- Wind energy

Wind energy can be economically used for generation of electrical energy. The wind energy available over the earth is estimated to be 1.6×10^7 MW , which is equivalent to the present energy consumption.

In India though wind speeds are generally low, attempts are being made for low-speed windmills for irrigation, power generation and for providing drinking water and electricity in rural areas in several states such as Tamil Nadu, Kerala, Gujarat, Rajasthan.

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Wind energy

Wind power generation capacity in India has significantly increased in recent years.

As of the end of October 2017 the total installed wind power capacity was 32.72 GW , mainly spread across the South, West and North regions. By the end of 2015, India had the fourth largest installed wind power capacity in the world.

India started planning in 2010 to enter into offshore wind power, and a 100 MW demonstration plant located off the Gujarat coast began planning in 2014.

Wind power generation by states

There is a growing number of wind energy installations in states across India.
Installed wind capacity by state as of 19 October 2016

State Total Capacity (MW)

- TamilNadu-7,684.31
- Maharashtra-4,664.08
- Gujarat-4,227.31
- Rajasthan-4,123.35
- Karnataka-3,082.45
- Madhya Pradesh-2,288.60
- Andhra Pradesh-1,866.35
- Telangana-98.70
- Kerala-43.50
- Others-4.30

Total--28,082.95 (2016)
-- 32.72 GW (2017)

An array of Wind Mills

Wind Turbine near Jaisalmer

Wind Turbines near Jaisalmer

Wind Turbines near Jaisalmer

Suzlon Group

Mr. Tulsi Tanti is the Founder, Chairman and Managing Director of Suzlon Group, an Indian MNC and a prominent player in the global renewable energy sector.

The group has a market capitalization of over USD 1.5 billion and an international presence across 18 countries in 6 continents.

Mr. Tulsi Tanti spearheaded the wind revolution in India with the founding of Suzlon Energy in 1995.

Internal Energy Sources

- Biomass Energy

Biomass is derived from plant resources, animal waste, by-products of timber industry, agriculture crop, raw material from forests and wood.

Biomass is the most important fuel after coal, petroleum and natural gas, so can be used to produce electricity.

Internal Energy Sources

In India, biomass accounts about 1/3 of the total fuels.

Over 90% of the rural households and 15% of the urban ones use biomass fuels (wood, cow dung cakes, crop residue, saw dust).

Insufficient burning causes air pollution and CO (toxic)

Biomass resources can be divided into:

- Biomass as traditional solid mass
- Biomass in non-traditional form (conversion into ethanol and methanol)
- Biomass for domestic use (biogas by fermenting the biomass an-aerobically.

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Biomass (or Bio-fuels)

Types of Biomass

- ***Biomass*** is all plant material, or vegetation, either raw or processed, wild or cultivated.
- ***Bio-fuel*** is a type of fuel whose energy is derived from biological carbon fixation.
- Bio-fuels are derived from biomass conversion, as well as solid biomass, liquid fuels and various biogases.
- ***Uses***- Industrial process heat and steam, Electrical power generation, Transportation fuels (ethanol and biodiesel) and other products.

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Bio-fuels in India

Biofuel in India

- Biofuel development in India centres mainly around the cultivation and processing of Jatropha plant seeds which are very rich in oil (40%).
- *Jatropha curcas L.* is grown in Tamilnadu, Karnataka, Andhra Pradesh, Maharashtra and other states for biodiesel production.
- It is drought resistant shrubs-
- India's total biodiesel requirement is projected to grow to 3.6 million tonnes in 2011–12, with the positive performance of the domestic automobile industry.



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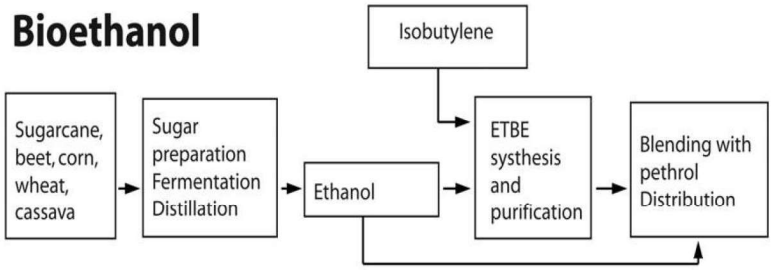
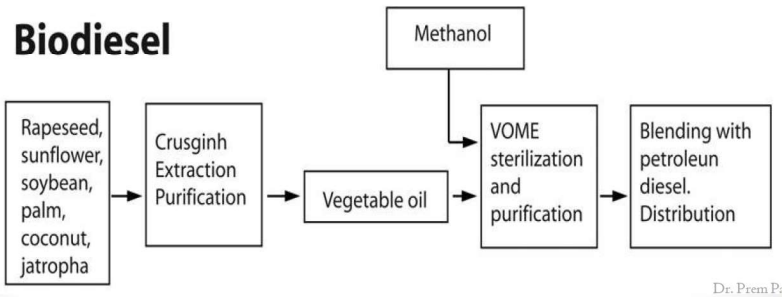
Bioethanol



Biodiesel



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Socio-Economic Benefits

- Helps developing economies by promoting agrarian communities
- Increase in jobs
- Increase in trade balance (Indian perspective) due to lesser dependence on foreign resources

Bio-refinery

- A facility that integrates biomass conversion processes and equipment to produce fuels, power, and chemicals from biomass.
- Analogous to today's petroleum refineries
- It is based on the "Sugar Platform" and the "Thermo chemical Platform"

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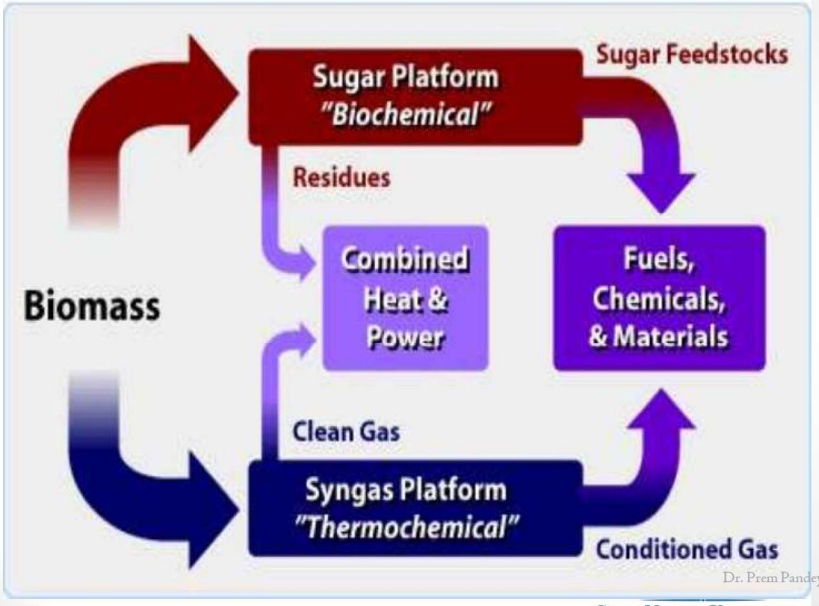
Biorefinery Concept



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First generation bio-fuels :

- Bioalcohols
- Biodiesel
- Green diesel
- Vegetable oil
- Bioethers
- Biogas
- Syngas
- Solid biofuels

Pipes carrying Biogas

Filtered waste vegetable oil

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The various Bio-fuels available…

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Internal Energy Sources

Terrestrial (geothermal) energy sources have a much smaller input than the sun, but greater than the tidal contribution

- Heat energy flows out through solid rocks at Earth's surface by conduction *(movement of heat from one solid to another through contact)*

Internal Energy Sources

- However, volcanoes involve the movement of hot material from inside the planet to outside, so some heat energy reaches the Earth's surface by convection *(transfer of heat from one place to another by the movement of fluids)*
- Convection is a very efficient way for the Earth to transfer heat from its interior to the surface, and convective heat transfer provides the driving force behind plate tectonics

Geothermal Energy

History :

- Hot Springs have been used for bathing at least since Paleolithic times
- The oldest known spa is a stone pool on China's Lisan mountain built in the Qin dynasty in the 3rd century BC, at the same site where the Huaqing Chi palace was later built.

Hot water springs form due to geothermal energy of the earth

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Mud bubbling and hot water geysers – New Zealand/Japan

Internal Energy Sources

Nuclear Energy

Nuclear energy is a clean energy and important source. These resources are about 10 times more than fossil fuels.

U^{235} (mineral) is the main fuel for nuclear energy.

Fission of 1 kg U^{235} releases energy equal to that obtained by burning 3 million tones of coal.

Nuclear Energy

Nuclear energy is used for electricity and for making radioactive isotopes for medical treatment purposes.

The cost of maintenance of atomic power plant is tremendous, while the effects of nuclear wastes in human health are extremely hazardous.

Accidents in the reactors, like in Chernobyl 1986, in Russia releases radio energy.

Nuclear waste must be buried in strong vaults/sea.

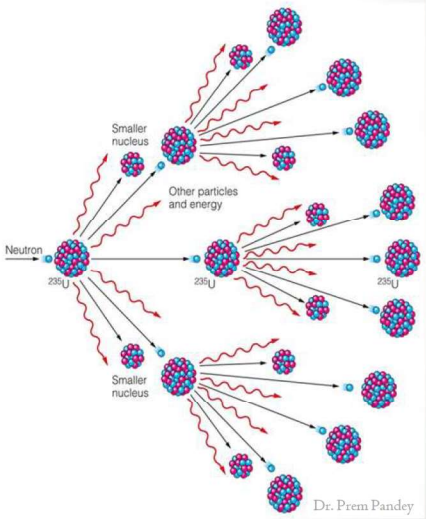
Internal Energy Sources

- Nuclear Energy

Can be generated in two ways

Fission: splitting heavy atoms into lighter atoms

Fusion: joining together of two small atoms to create a single larger atom - like the Sun - but not available with our current technology



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Nuclear Energy in India

Nuclear power is the fourth-largest source of electricity in India after thermal, hydroelectric and renewable sources of electricity.

India has 21 nuclear reactors in operation in having an installed capacity of 5,780 MW and producing a total of 30,292.91 GWh (Gigawatt hour)

(1,000.00 MWh converts to 1 GWh)

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Nuclear Energy in India

Largest Nuclear Power Plant: Kudankulam Atomic Power Project, Tamil Nadu, i Unit, 1000 MWe capacity, December 31, 2014

Smallest Nuclear Power Plant: Rajasthan Atomic Power Station (RAPS), RajasthanI Unit, 100 MWe capacity, December 16,1973

In Uttar Pradesh: Narora, NPCIL Uttar Pradesh, 220 x 2 Units, 440 MW

Nine more to be constructed in Tamil Nadu (2), Karnataka (I), Rajasthan (I), Andhra Pradesh (I), Madhya Pradesh (I), Haryana (I), Maharashtra (I), Gujarat (I)

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122

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Unit 2: Natural Resources

- Introduction, types of natural resources
- Non-renewable resources
- Renewable resources
- Minerals
- Energy
- **Energy in India: an overview**
- Role of an individual in conservation of natural resources

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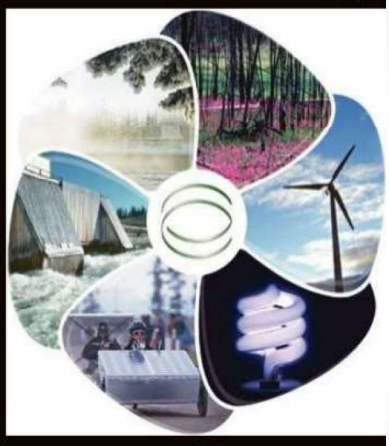
Energy in India: Renewable Resources

- About 16% of global final energy consumption comes from renewables, with 10% coming from traditional biomass (used for heating) and 3.4% from hydroelectricity.
- New renewables (small hydro, modern biomass, wind, solar, geothermal, and bio-fuels) accounted for another 3% consumption and are growing very rapidly.
- The electrical generation globally is mainly from hydroelectricity and the rest from new renewables.

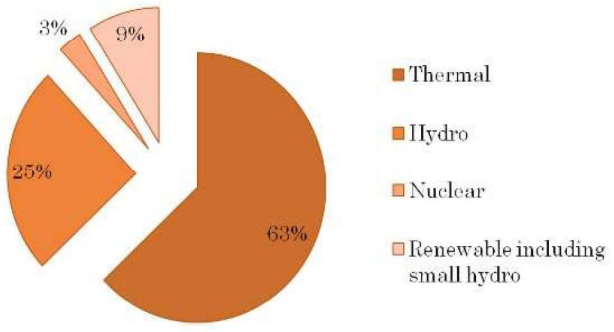


ENERGY IN INDIA: AN OVERVIEW

- India consumes 3.7% of the world's commercial energy making it the 5th largest consumer of energy globally.
- Total installed capacity of 1,44,912 MW.
- 350 kgoe per capita primary commercial energy consumption. 22% of world average.
- Per capita electricity consumption: 600 kWhr per year.
- About 80% of total rural energy consumption comes from non-commercial energy.
- 84% villages electrified. 44% of rural households electrified.

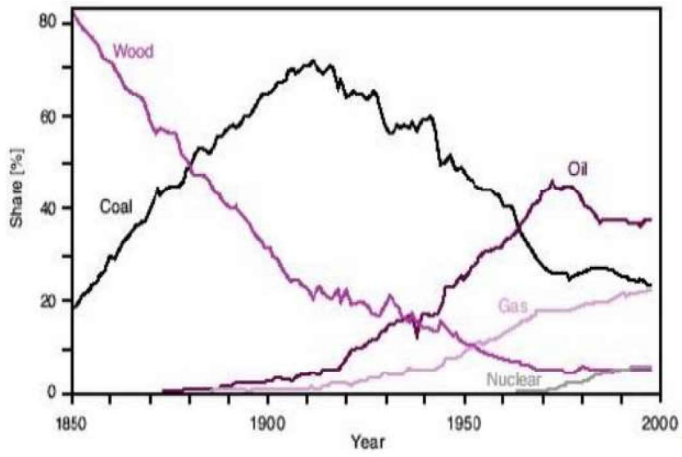
INDIAN POWER SECTOR

Total Installed Capacity: 1,44,912 MW



Source: Ministry of New and Renewable Energy

ENERGY CONSUMPTION TREND



ENERGY SCENARIO IN INDIA

- Rapid economic development & Increasing population = High demand for Energy
- A sustained 8% GDP growth of India requires an annual increase of:
  - a) Commercial energy supply from 3.7% to 6.1%
  - b) Total primary energy supply from 2.2% to 5.1%
- Limited supply of COAL, coupled with its poor quality, low level of technologies advancements and high environmental hazards.
- Limited domestic reserves and uncertain foreign supply of hydrocarbons.

WHY RENEWABLE ENERGY FOR INDIA?

- Power shortage
- Rising Prices of Oils & Gases
- Ecological Hazards
- Ample resources and sites available
- Abundant sunshine
- Government incentive
- Increased financing options

BENEFITS OF RENEWABLE ENERGY

- Avoid the high costs involved in transmission capex.
- Avoid distribution losses – Technical & otherwise
- Avoid recurring fuel cost
- Boost the rural economy
- Encourage self help groups & self dependence
- Enable village co-operatives to supply and / or monitor distribution
- Make available much needed energy for basic needs at the doorstep at affordable prices.

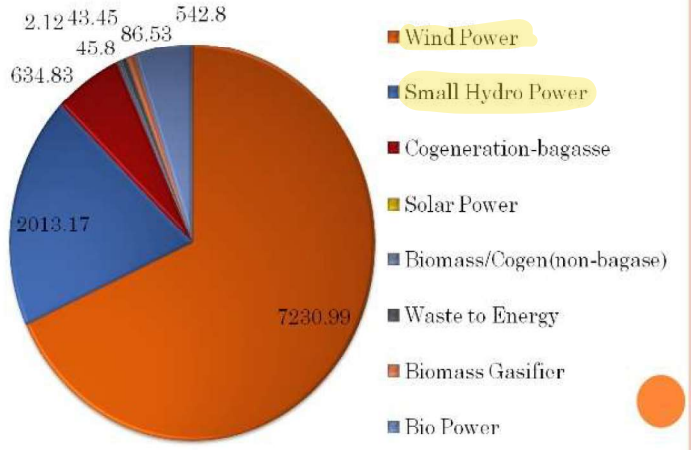
POTENTIAL

Renewable Resource	Estimated	Remarks
Wind Power	45,000 MW	Sites with wind densities of 300 W/ m2 or higher with 9% of assessed area available for wind farms requiring 12 ha/MW.
Biomass Power	45,000 MW	20 mha of wastelands yielding 10 MT/ha/annum of woody biomass giving 4000 kcal/ kg with system efficiency of 30% and operating at 75% PLF.
Solar Power	50,000 MW	Assuming solar energy: 4-6 kWhr/ m2/ day and depending upon future developments making solar technology cost-competitive for grid power applications.
Small Hydro Power	15,000 MW	
Bio-Energy	24,000 MW	

Source: Ministry of New and Renewable Energy

INSTALLED CAPACITY FROM RENEWABLE ENERGY

Total Power from Renewables: 10,619.45MW



Source: Ministry of New and Renewable Energy

Status of power generation in India from renewable resources

Resource	Gross potential	Achieved
Wind	45,000 MW	6270 MW
Solar thermal	35 MW/km^2	-
Solar photovoltaic	22 MW/km^2	224 MW
Biomass	3,500 MW	381 MW
Small hydro	15,000 MW	1,663 MW

INDIAN WIND ENERGY SECTOR OVERVIEW

CURRENT SCENARIO

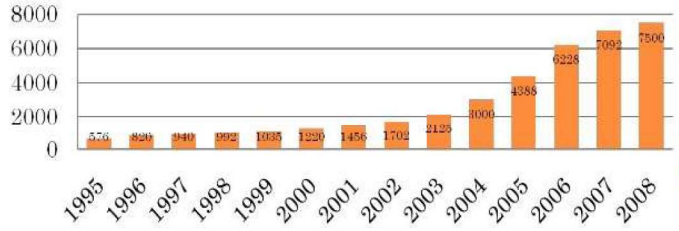
- 4th largest producers of wind energy in the world.
- India's current installed wind capacity is 8.7 GW (approx. 10% of the world's total installed capacity).
- Capacity growth has been strong with a 22% CAGR over last decade.
- Tamil Nadu, Maharashtra & Karnataka are the leaders in wind capacity.

INDIAN WIND ENERGY SECTOR OVERVIEW

FUTURE POTENTIAL

- Cumulative installed capacity is expected to reach 12 GW by 2010.
- Generation based subsidy of Rs 0.50per unit recently announced for 10 years (limit of 5 MW per developer and 50 MW in aggregate).

Wind Energy Capacity in India



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INDIAN SOLAR ENERGY MARKET OVERVIEW

MASSIVE POTENTIAL OF INDIA

- Huge potential for Solar Energy development in India
- High sunshine days, abundance of sites make Solar energy an enticing prospect

MARKET IN GROWTH STAGE

- Installed manufacturing capacity has grown from a meager 10 MW in 2000 to a total of 335 MW by 2007.
- India is now 7th worldwide in Solar PV Cell production
- Generation capacities expected to pick up with generation linked subsidy announced by government

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INDIAN HYDRO POWER SECTOR OVERVIEW

POTENTIAL FOR HYDRO POWER GENERATION

- India ranks 8th in terms of hydro-electricity generated
- Potential to provide energy in remote and hilly areas where extension of an electrical transmission grid system is uneconomical
- Till now, 14 States have announced policies for setting up commercial SHP projects.

KEY POSITIVE

- Proven Technology
- Low O&M Costs
- High energy conversion efficiency (70%)

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141

INDIAN HYDRO POWER SECTOR OVERVIEW

KEY DRAWBACKS

- High gestation period
- High capital costs (per MW)
- Social Costs

FUTURE POTENTIAL

- Hydro capacity expected to reach 57 GW by 2012.
- Small hydro potential is expected close to 15 GW.
- MNRE has introduced subsidy schemes for SHPs up to 25 MW.
- Well-established manufacturing base for full range and type of small hydro equipments.

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142

Unit 2: Natural Resources

- Introduction, types of natural resources
- Non-renewable resources
- Renewable resources
- Minerals
- Energy
- Energy in India: an overview
- **Role of an individual in conservation of natural resources**

Perspectives and Actions

- Most of the natural resources are scarce, limited and precious and should be used more efficiently.
- In rural areas in India , drinking water has to be brought from long distances.
- Even several of the towns do not have municipal water supply system.

Perspectives and Actions

- China and India overuse many resources due to large population.
- However, the per capita consumption of resources of the developed countries is about 50 times greater than in most of the developing countries.

Perspectives and Actions

- An investment for natural resources may benefit a part of the population and harm another.
- Various nations over the globe, especially in the developing countries must formulate policies for equitable distribution of natural resources.

What can we do to save energy?

- Do not discharge municipal waste on land or into water bodies.
  Conserve water. It's the most important for our life.
- Use pressure cooker. It is faster and can save up to 75% of the energy.
- Soak lentils before cooking. This consumes less energy. Keeping the vessel covered while cooking, thus saving energy.

What can we do to save energy?

- Keep bulbs and tube clean. Dust on them attenuate lightening by 20-25%.
- Use tube lights and energy-efficient bulbs –CFL/LED that save energy rather than normal bulbs.
- A 40 W tube light gives as much light as a 100 W bulb.
-

What can we do to save energy?

- Develop respect for all forms of life.
- Plant trees. They reduce atmospheric pollution.
- Reduce to use wood and paper products. Try to recycle products and use recycled paper.
- Join an afforestation program.
- Advocate organic farming by asking your grocery store to stock organically grown vegetables and fruits. This will spare you from the risk of pesticides.

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What can we do to save energy?

- Reduce to use fossil fuels either by walking small distances or by using public transport.
- Switch off lights and fans when not needed.
- Do not pour pesticides, paints solvents, oil or products containing harmful chemicals down the drain or on the ground.

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150
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What can we do to save energy?

- Buy consumer goods in refillable glass containers instead of can or throw away bottles.
- Use rechargeable batteries.
- Say no to plastic carry bags and plastic bottles. Use your own cloth bag for shopping.

What can we do ?

- Do not use disposal papers or plastic plates when reusable versions are available.
- Recycle newspapers, aluminum, etc…
- Set up a compost bin in your garden and use it to produce manure from your plant wastes. Do not use chemical fertilizers.
- Do not use leaded petrol in your vehicles. Use catalytic converters. Discard old vehicles, new ones are filled with better technologies.
- Do not burn garbage. Plastics emit dangerous toxic fumes. Recycle them.


Thanks…!!!
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153
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