

Environmental Chemistry Theory

CY1018



भारतीय प्रौद्योगिकी संस्थान हैदराबाद
Indian Institute of Technology Hyderabad

Department of Chemistry

Course Content

Know our environment (chemistry of lithosphere, energy balance, sustainability and recycle), Know about global warming (infrared absorption, molecular vibration, atmospheric window, residence time of greenhouse gases, evidences and effects of global warming)

Deeper analysis of atmospheric pollution (Chemistry of CO, NO_x, VOCs, SO₂, Industrial smog, photochemical smog), Ozone depletion (production, catalytic destruction)

Organic Chemicals in the Environment, Insecticides, Pesticides, Herbicides and Insect Control, Soaps, Synthetic Surfactants, Polymers, and Haloorganics. Fate of organic/inorganic chemicals in natural and engineered systems (fate of polymers after use, detergents, synthetic surfactants insecticides, pesticides etc. after use)

Aspects of transformations in atmosphere (microbial degradation of organics-environmental degradation of polymers, atmospheric lifetime, toxicity). Green Chemistry and Industrial Ecology. Future challenges (CO₂ sequestering, Nuclear energy). A project on environment related topic.



Sustainability, Energy resources & Recycling

Foundations of human well-being

Human well-being is supported by three pillars:

- economic conditions and processes

employment, income & wealth (magnitude & distribution),
markets, trade...

- sociopolitical conditions and processes

law & order, national & homeland security, governance, liberty,
justice, equity, education, health care, science, culture & the
arts...

- environmental conditions and processes

air, water, soils, mineral resources, the biota, nutrient cycles,
climatic processes...

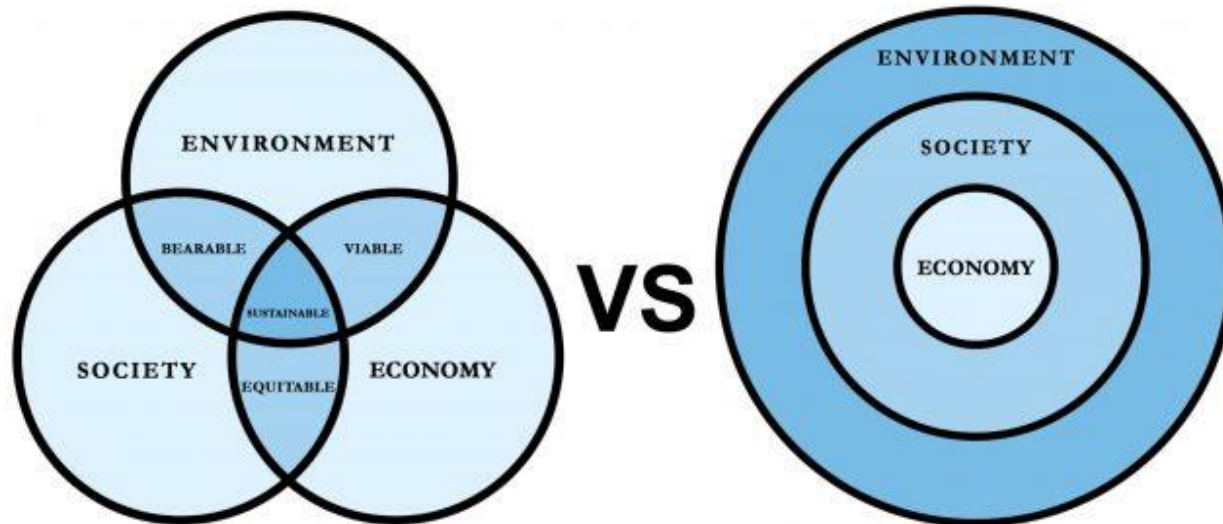
“Development” and “sustainability”

- Development should mean improving human well-being in all 3 dimensions — economic, sociopolitical, and environmental.
- Sustainable development should mean doing so by means & to end points consistent with maintaining the improvements indefinitely.

Sustainability - Definition

“Everything that we need for our survival and well-being depends either directly or indirectly on our natural environment. Sustainability creates and maintains the conditions under which humans and nature can exist in productive harmony, [conditions] that permit fulfilling the social, economic and other requirements of present and future generations.”

“Sustainability is the process of living within the limits of available physical, natural and social resources in ways that allow the living systems in which humans are embedded to thrive in perpetuity.”





What Is Recycling?

We all make rubbish each day. Rubbish is not good for the planet we live on and if we don't do something to reduce the amount of rubbish in our world it could damage it.

To lower the amount of rubbish in the world we can recycle.

Recycling means taking objects and using the materials they are made from to make something new.

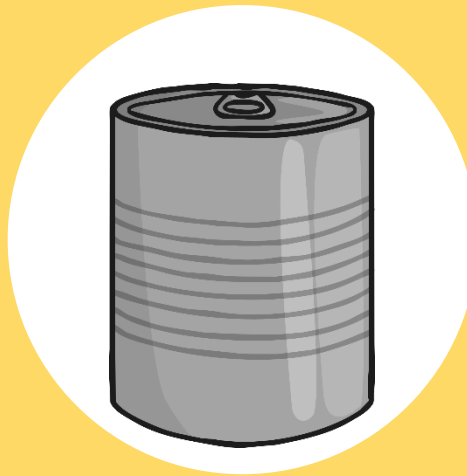


What Is Recycling?

Examples of Recycling:



Paper can be recycled to make new paper or a toilet roll.



A tin can could be recycled to make chocolate wrapping and new drinks or food cans.



Glass can be recycled to make new bottles and jars.

What Happens to Things When They Are Recycled?



After you have placed your object for recycling in the recycling bin it will be taken away to a recycling factory, shredded into very small pieces and melted down (metals, glass and plastic) into a liquid or pulp before being used to create something new.

“Recycling doesn't just save materials: it saves energy too”

The 3 'R's of Recycling



R

Reduce

Think about things you are about to throw away. Could they be used again or do a different job? If we can use things again it reduces the amount of rubbish we create.



R

Reuse

Could the items you no longer need be used by someone else who might like them? You could give them to friends or family or take them to a charity shop.



R

Recycle

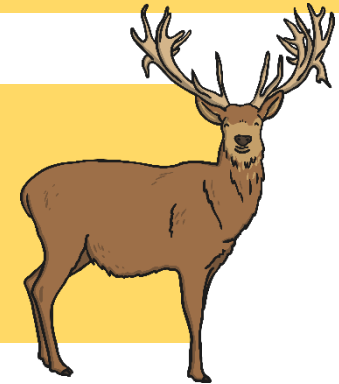
If you cannot reduce or reuse your rubbish, then recycle it. Take them to your nearest recycling bank or add to your recycling bin and it will be made into something completely new.

Why Is Recycling Important?



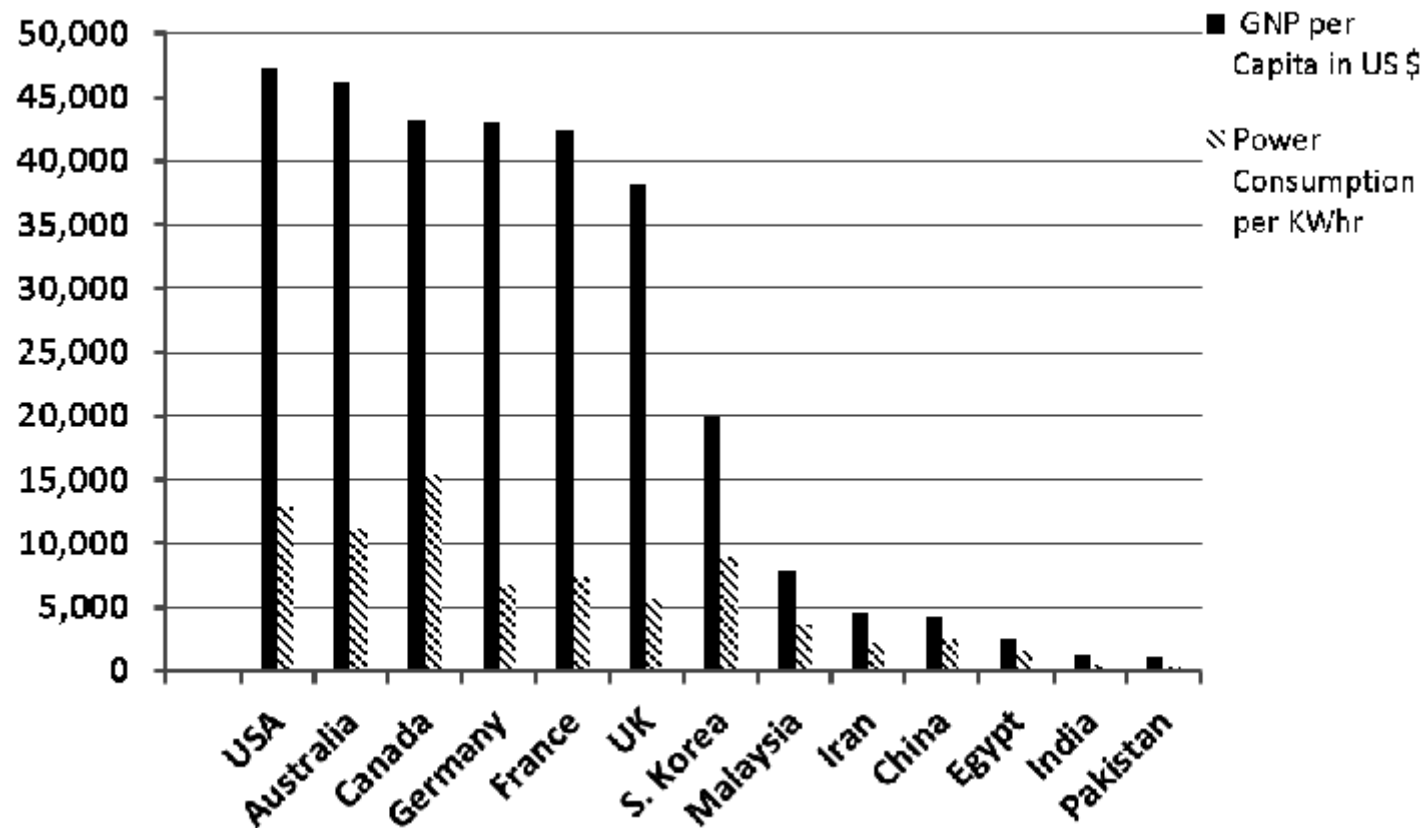
If materials are recycled it saves natural resources having to be taken from the earth to make new things.

Recycling saves energy and stops pollution like gases which can harm animals and plants.



Land which is used to store rubbish can be used for other things and poisonous liquids which could leak from rubbish are destroyed.

Per capita energy use and GNP



GNP = Gross National Product

KWhr= Kilowatt - hour

Energy Resources

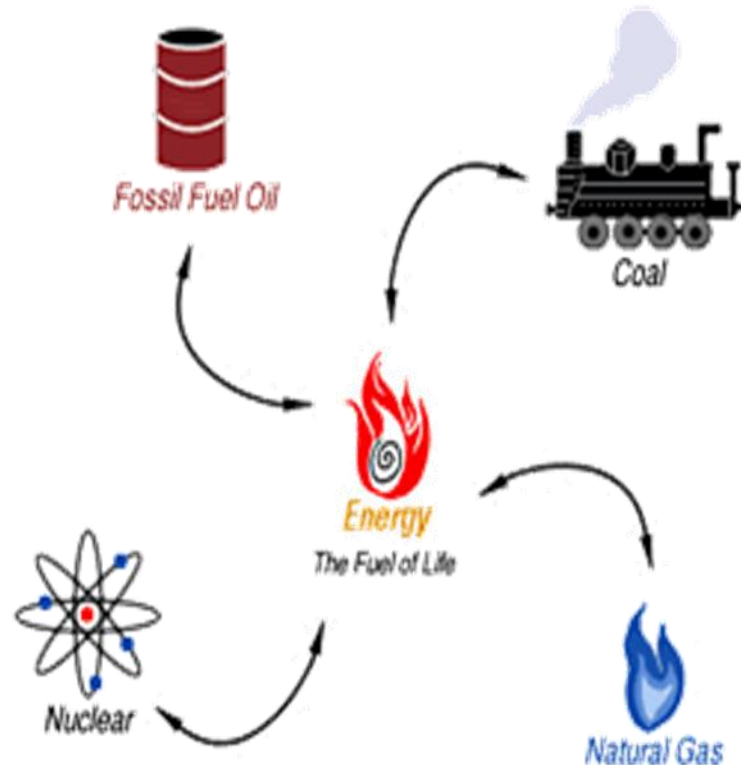


Energy Resources

A non-renewable resource is a natural resource that cannot be readily replaced by natural means at a quick enough pace to keep up with consumption.

Non- renewable energy resources:

- ❖ Oil
- ❖ Natural gas
- ❖ Coal
- ❖ Nuclear energy.



Oil

- ❖ **Petroleum, or crude oil (oil as it comes out of the ground)**, is a black, gooey liquid consisting of hundreds of different combustible hydrocarbons along with small amounts of sulfur, oxygen, and nitrogen impurities.
- ❖ Oil supplies about **one-third of the world's commercial Energy**.
- ❖ We use oil to grow most of **our food, transport people and goods**, and make most of the things we use every day.
- ❖ The products of crude oil distillation, called **petrochemicals, are used as raw materials in industries**.
- ❖ Conventional oil is currently abundant, has a high net energy yield, and is relatively inexpensive, but using it causes **air and water pollution** and releases greenhouse gases to the atmosphere.
- ❖ Heavy oils from **tar sand and oil shale** exist in potentially large supplies but have low net energy yields and higher environmental impacts than conventional oil has.

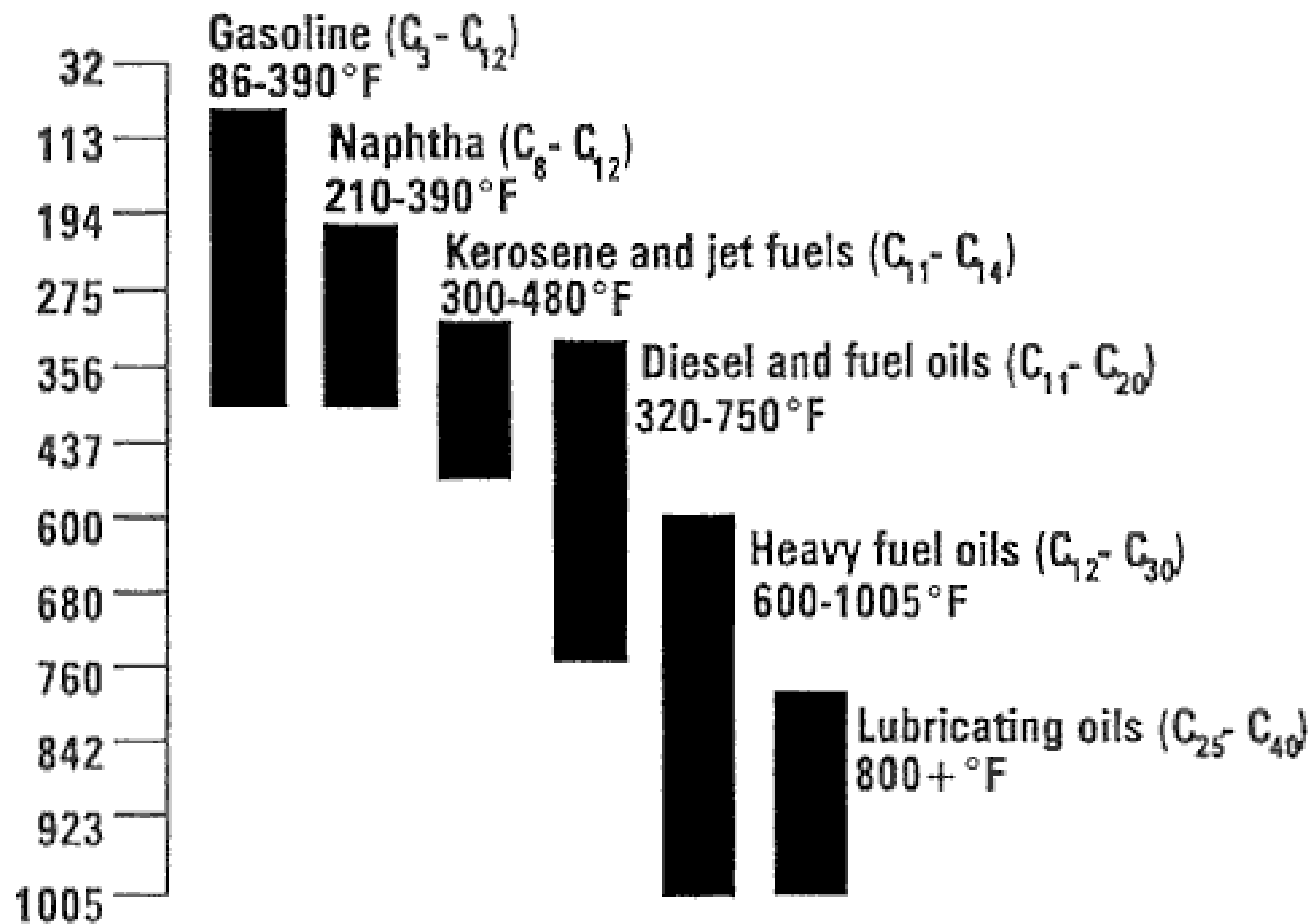


Fig. A-1 Hydrocarbon composition and boiling ranges for major refined products

Liquefied Petroleum Gas (LPG)

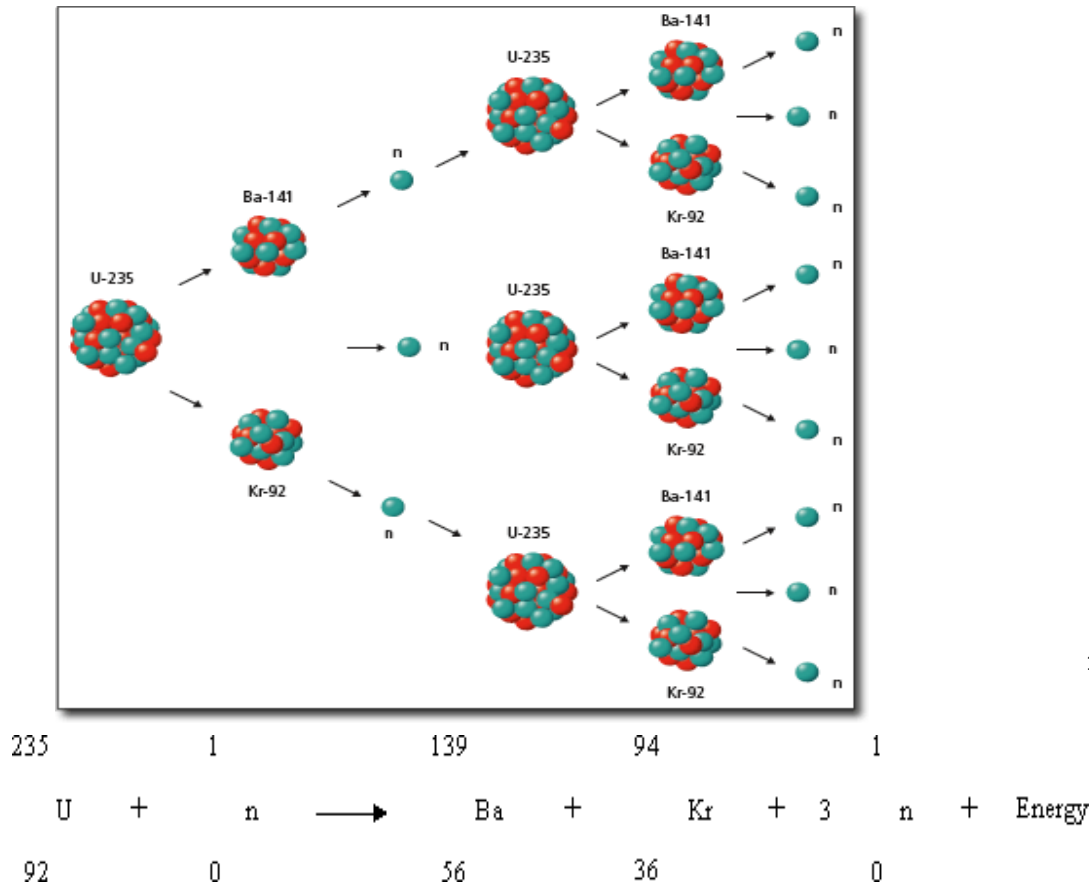
- The main component of petrol is **butane**, the other being propane and ethane
- Under pressure, petroleum is converted to LPG
- It is odourless
- In domestic gas cylinders ethyl mercaptan, a foul smelling gas, is added
- In India at Digboi (Assam), Gujarat plains, Bombay high, deltaic coasts of Godhavari, Krishna, Kaveri and Mahanadhi.

COAL

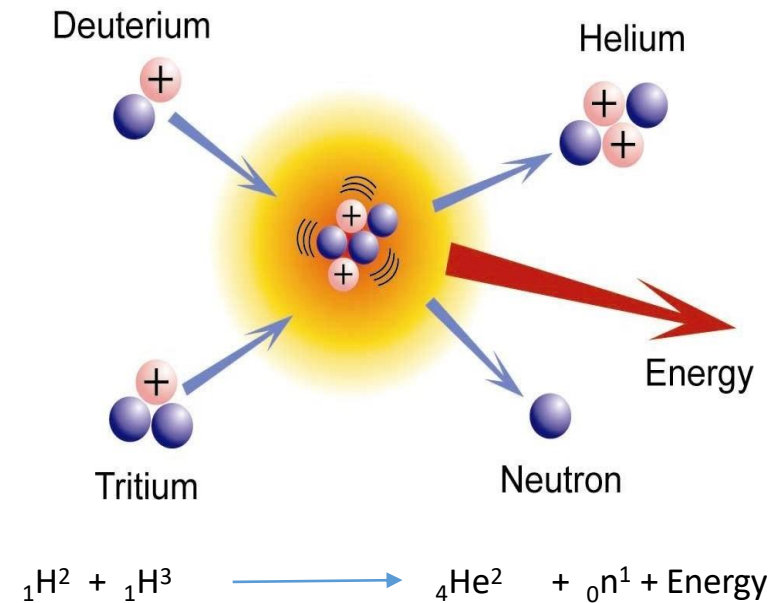
- Coal was formed 350 million years ago in the hot, damp regions of the earth during the carboniferous age.
- **Anthracite** [hard coal, 90% carbon, 8700 kcal/kg)
- **Bituminous** [Soft coal, 80% carbon]
- **Lignite** [Brown coal, 70% carbon]
- The coal reserves are likely to last for about 200 years, if the use increased by 2% per year, then it will last for another 65 years
- India has 5% of world's coal and Indian coal is not very good in terms of heat capacity
- Major coal fields in India are
 - Raniganj, Jharia, Bokaro, Singrauli, Godavari valley
- The coal state of India are
 - Jharkhand, Orissa, West Bengal, Madhya Pradesh, Andhra pradesh, Maharashtra

Nuclear Energy

Nuclear Fission



Nuclear Fusion



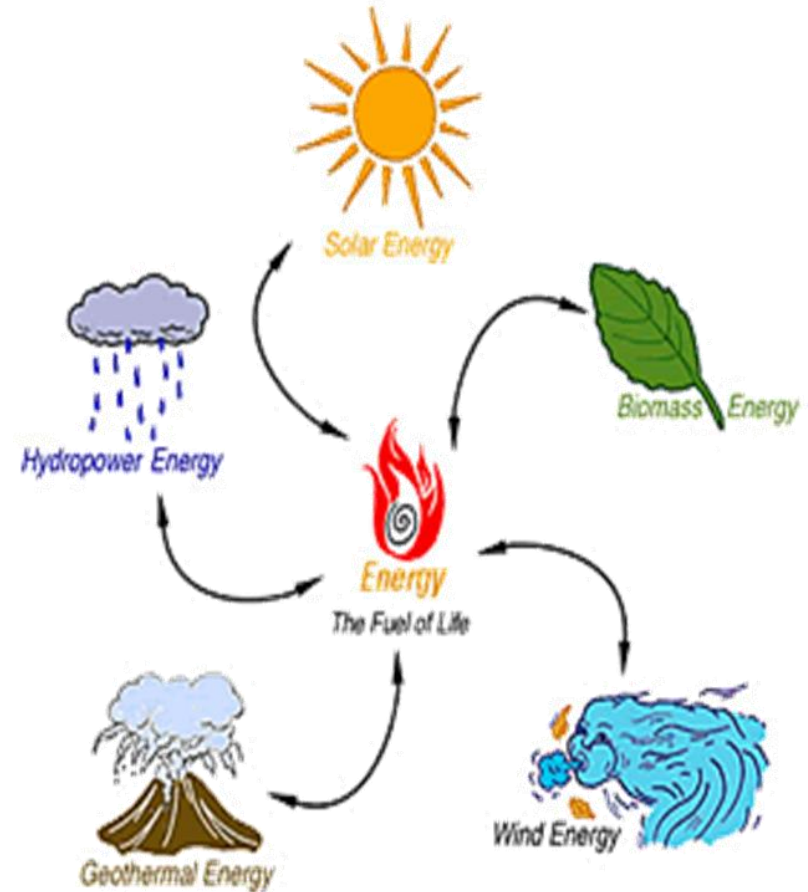
There are four nuclear power stations with an installed capacity of 2005 MW
 Tarapur (Maharashtra), Rana Pratap Sagar (Rajasthan), Kalpakkam (Tamilnadu), and Narora (U.P)

Renewable Energy Resources:

Renewable energy is energy that is collected from renewable resources, which are naturally replenished on a human timescale, including carbon neutral sources like sunlight, wind, rain, tides, waves, and geothermal heat.

Renewable Energy Resources:

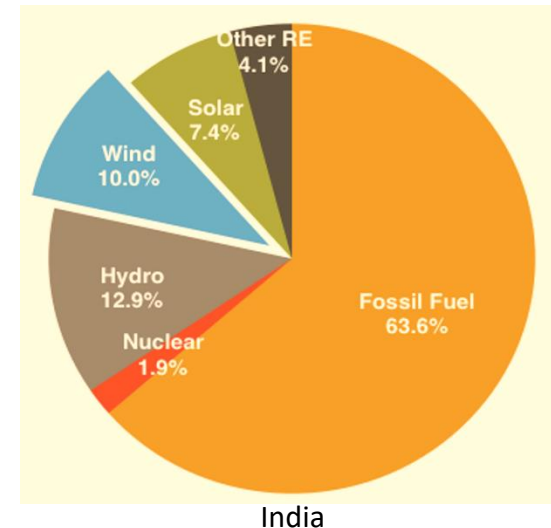
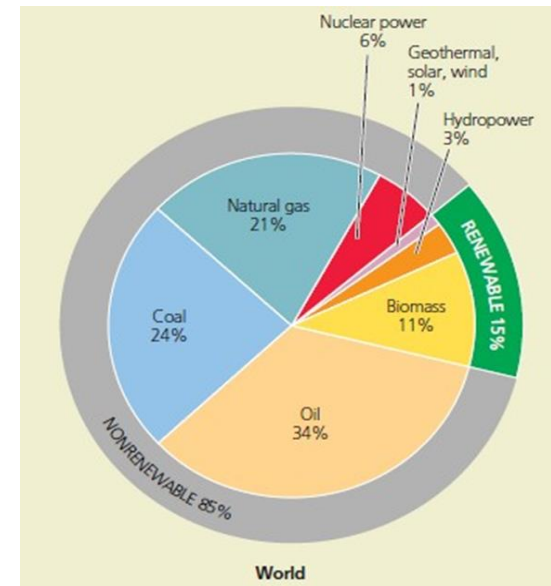
- ❖ Solar energy
- ❖ Hydroelectric power
- ❖ Ocean thermal energy
- ❖ Wind Energy
- ❖ Geothermal energy
- ❖ Energy from biomass.



<https://www.youtube.com/watch?v=KEeH4EniM3E>

Energy Use – Net Energy

- ❖ We get most of our energy by burning carbon-containing fossil fuels .
- ❖ Note that oil is the most widely used form of commercial energy and that about 79% of the energy used in the world.
- ❖ Net energy is the amount of high-quality energy available from an energy resource minus the amount of energy needed to make it available.
- ❖ Net Energy Is the Only Energy That Really Counts.
- ❖ Energy Resources With Low or Negative Net Energy Yields Need Help to Compete in the Marketplace.
- ❖ Reducing Energy Waste Improves Net Energy Yields and Can Save Money.



Solutions

Making the Transition to a More Sustainable Energy Future

Improve Energy Efficiency

Increase fuel-efficiency standards for vehicles, buildings, and appliances

Provide large tax credits or feebates for buying efficient cars, houses, and appliances

Reward utilities for reducing demand for electricity

Greatly increase energy efficiency research and development



More Renewable Energy

Greatly increase use of renewable energy

Provide large subsidies and tax credits for use of renewable energy

Greatly increase renewable energy research and development

Reduce Pollution and Health Risk

Phase out coal subsidies and tax breaks

Levy taxes on coal and oil use

Phase out nuclear power subsidies, tax breaks, and loan guarantees

What Can you do for efficient energy consumption?

Attic

- Hang reflective foil near roof to reflect heat.
- Use house fan.
- Be sure attic insulation is at least 30 centimeters (12 inches).

Bathroom

- Install water-saving toilets, faucets, and shower heads.
- Repair water leaks promptly.

Kitchen

- Use microwave rather than stove or oven as much as possible.
- Run only full loads in dishwasher and use low- or no-heat drying.
- Clean refrigerator coils regularly.

Basement or utility room

- Use front-loading clothes washer. If possible run only full loads with warm or cold water.
- If possible, hang clothes on racks for drying.
- Run only full loads in clothes dryer and use lower heat setting.
- Set water heater at 140°F if dishwasher is used and 120°F or lower if no dishwasher is used.
- Use water heater thermal blanket.
- Insulate exposed hot water pipes.
- Regularly clean or replace furnace filters.

Outside

Plant deciduous trees to block summer sun and let in winter sunlight.

Other rooms

- Use compact fluorescent lightbulbs or LEDs and avoid using incandescent bulbs.
- Turn off lights, computers, TV, and other electronic devices when they are not in use.
- Use high efficiency windows; use insulating window covers and close them at night and on sunny, hot days.
- Set thermostat as low as you can in winter and as high as you can in summer.
- Weather-strip and caulk doors, windows, light fixtures, and wall sockets.
- Keep heating and cooling vents free of obstructions.
- Keep fireplace damper closed when not in use.
- Use fans instead of, or along with, air conditioning.

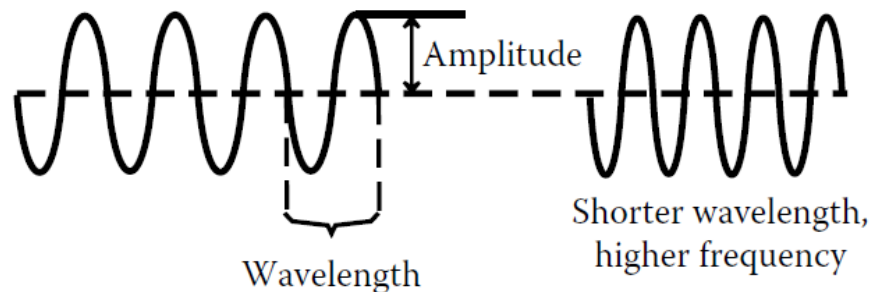
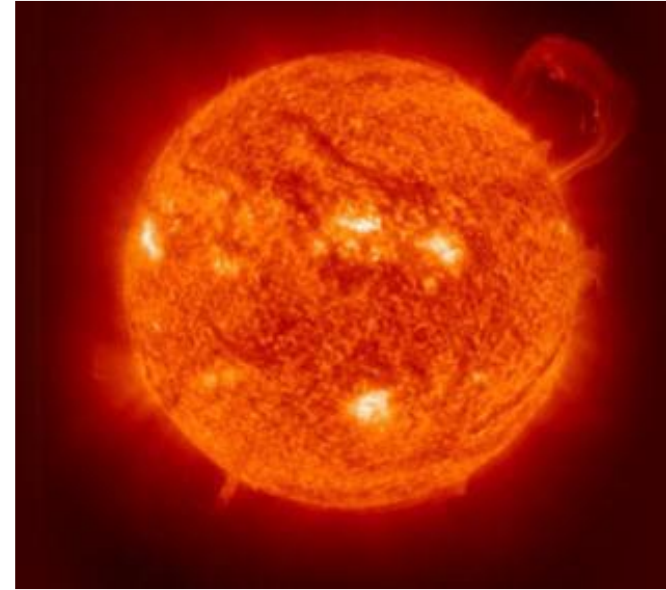


Sun light – The source of life

Biogeochemical cycles and virtually all other processes on the Earth are driven by energy from the sun.

Energy can be carried through space at the speed of light (c), 3.00×10^8 meters per second (m/s) in a vacuum, by **electromagnetic radiation**, which includes visible light, ultraviolet radiation, infrared radiation, microwaves, radio waves, g-rays, and x-rays.

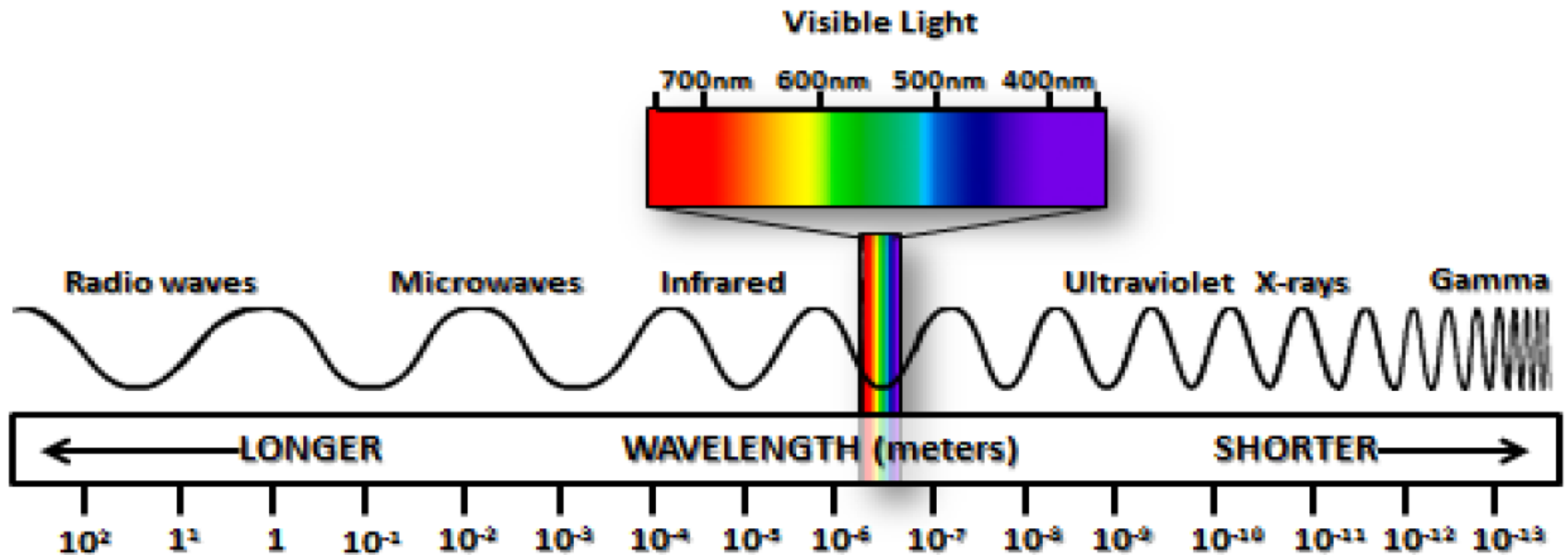
$$E = h\nu = \frac{hc}{\lambda}$$



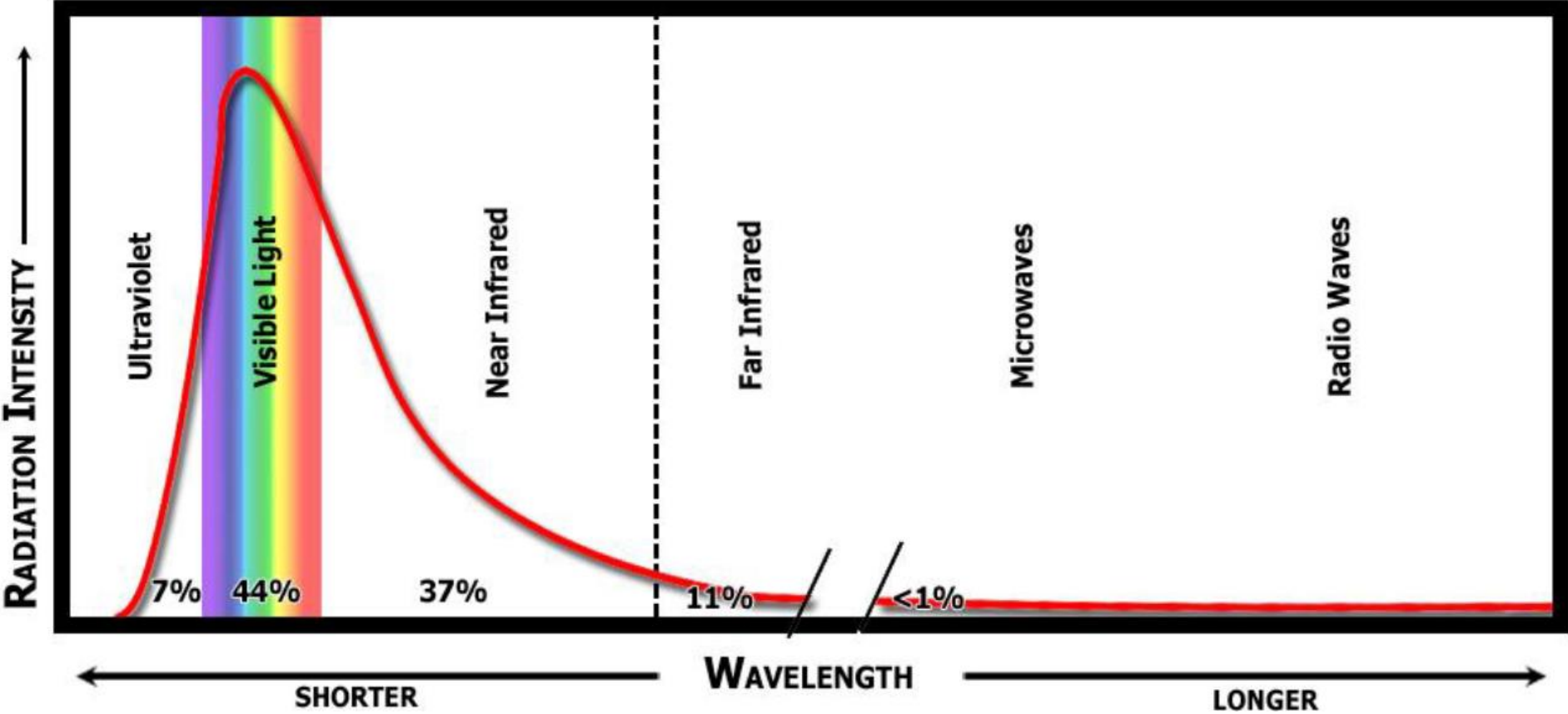
Electromagnetic Spectrum

The electromagnetic spectrum represents the complete range of electromagnetic radiation. The region of the spectrum with a shorter wavelength than the color violet is referred to as ultraviolet radiation, and the region of the spectrum with a longer wavelength than the color red is referred to as infrared radiation.

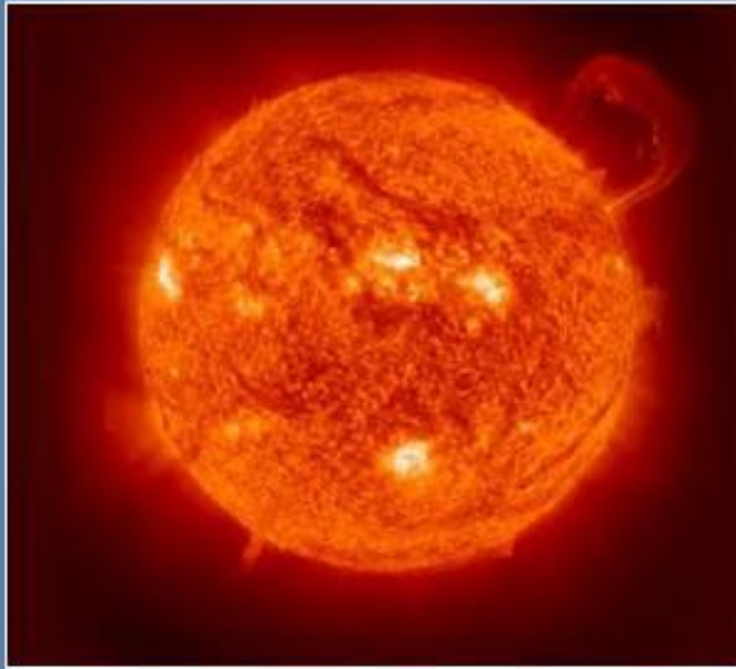
The Electromagnetic Spectrum



Sun's Electromagnetic Spectrum



THE RADIATION OF THE SUN VERSUS EARTH



SOLAR RADIATION
Shorter Wavelength
(higher frequency) emits
MORE ENERGY



TERRESTRIAL RADIATION
Longer Wavelength
(lower frequency) emits
LESS ENERGY

