

GE 2211 Environmental Science and Engineering

Unit – I

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Energy Resources

M. Subramanian

Assistant Professor
Department of Chemical Engineering
Sri Sivasubramaniya Nadar College of Engineering
Kalavakkam – 603 110, Kanchipuram (Dist)
Tamil Nadu, India
[msubbu.in\[AT\]gmail.com](mailto:msubbu.in[AT]gmail.com)

Contents

- energy resources: growing energy needs, renewable and non renewable energy sources, use of alternate energy sources – case studies

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Coal

- Readily combustible material, black or brownish-black material
- Coal was formed from layer upon layer of annual plant remains accumulating slowly that were protected from biodegradation by usually acidic covering waters that gave a natural antiseptic effect combating microorganisms and then later mud deposits protecting against oxidization
- Coal, a fossil fuel, is the largest source of energy for the generation of electricity worldwide, as well as one of the largest worldwide anthropogenic sources of carbon dioxide emissions
- Approximately 40% of the world electricity production uses coal
- To last for another 200 years, at the present rate of utilization

Types of Coal

- Peat – a precursor of coal
- Lignite – brown coal, the lowest rank of coal, exclusively used for electricity generation
- Sub-bituminous coal – used as fuel for electricity generation, synthesis of light aromatic hydrocarbons
- Bituminous – fuel for electricity, coke
- Anthracite – residential and commercial space heating
- Graphite – difficult to ignite, used for producing lubricants

Coal



Coal mining: http://commons.wikimedia.org/wiki/File:Strip_coal_mining.jpg 14-May-2009

Environmental Effects of Coal Usage

- Release of carbon dioxide – Coal is the largest contributor to the human-made increase of CO₂ in the air
- Generation of hundred of millions of tons of waste products, including fly ash, bottom ash, flue gas desulfurization sludge, that contain mercury, uranium, thorium, arsenic, and other heavy metals
- Acid rain from high-sulfur coal
- Dust nuisance

Fossil Fuel Reserves

- Coal - 1 trillion ton (as on 2003)
- Oil - 0.2 trillion m³ (in 2003)
 - Saudi Arabia – the largest share of 23%

Rank	Country	% share
1	USA	25.4
2	Russia	15.9
3	China	11.6
4	India	8.6

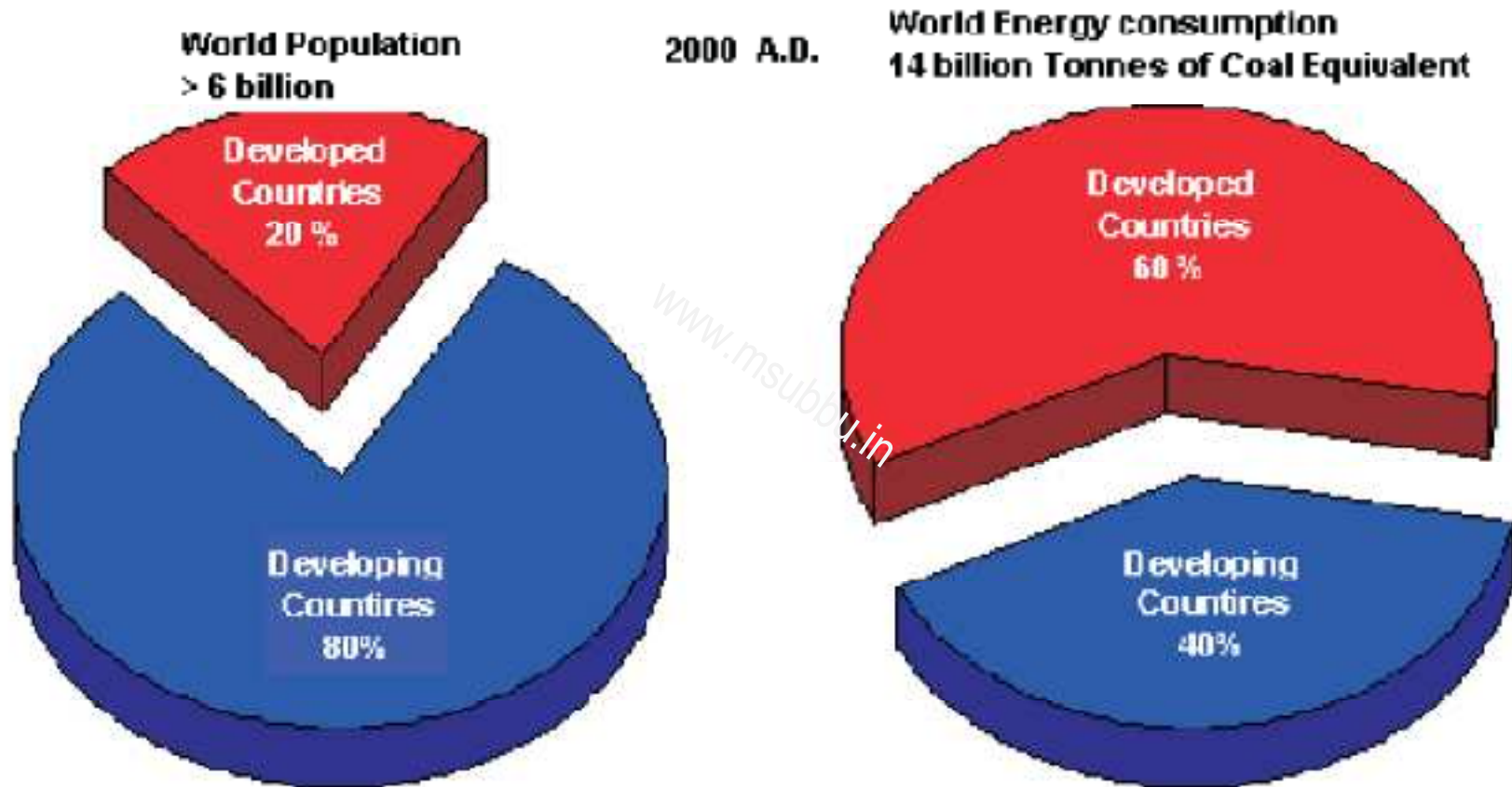
Coal reserves

- Gas - 176 trillion m³ (2003) ~ 0.16 trillion ton
 - Russia has the largest share of 27%

Energy Content of Fuels

- Coal: energy content ~ 24 GJ/Ton (6.67 kW·h/kg)
 - The typical thermodynamic efficiency of coal power plants is about 30%, so of the 6.67 kW·h of energy per kilogram of coal, 30% of that—2.0 kW·h/kg—can successfully be turned into electricity; the rest is waste heat. So coal power plants obtain approximately 2.0 kW·h per kilogram of burned coal.
- Oil: 42 GJ/Ton
- Natural Gas: 54 GJ/Ton

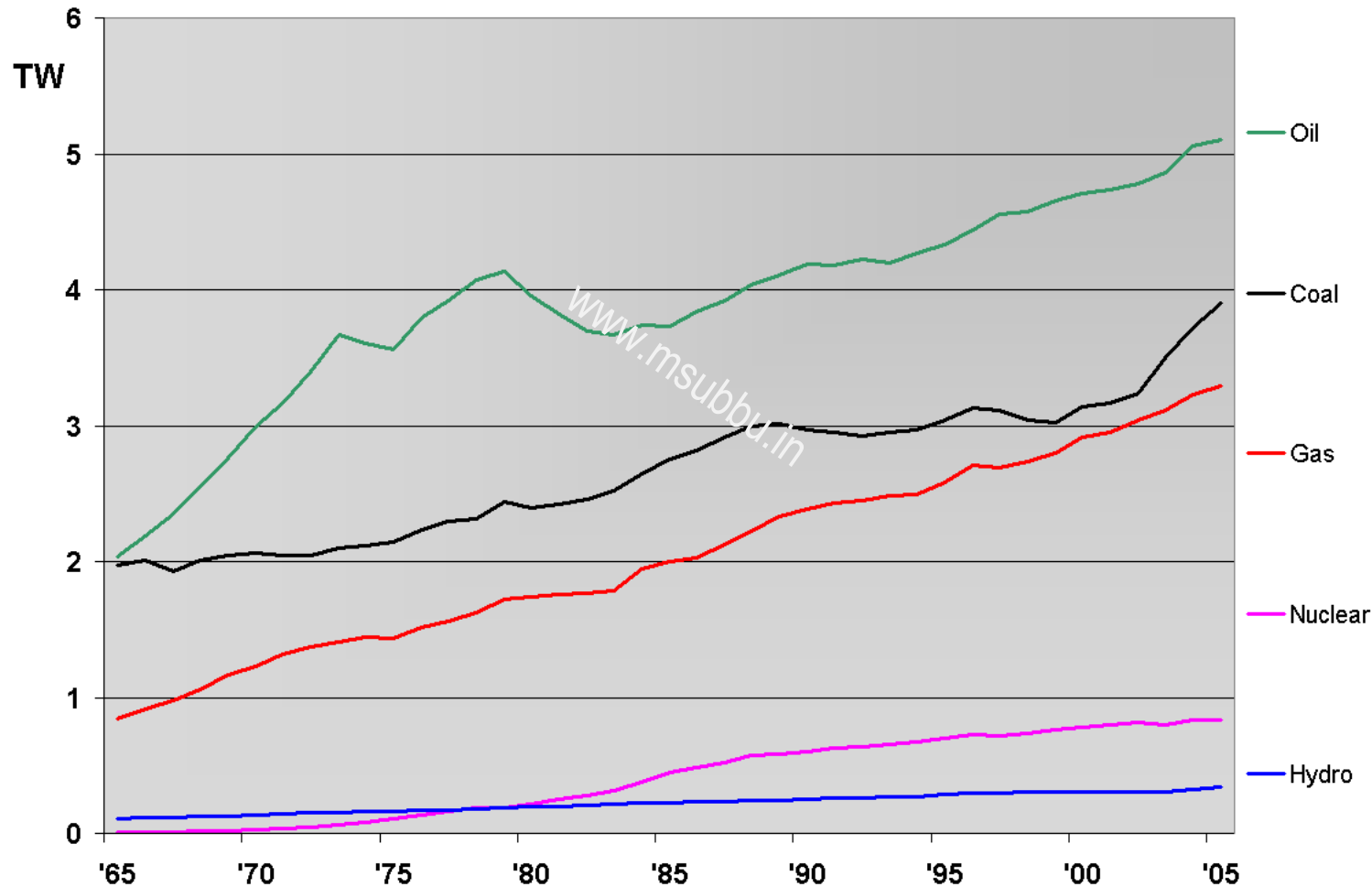
Energy Usage Distribution



Energy Usage Distribution

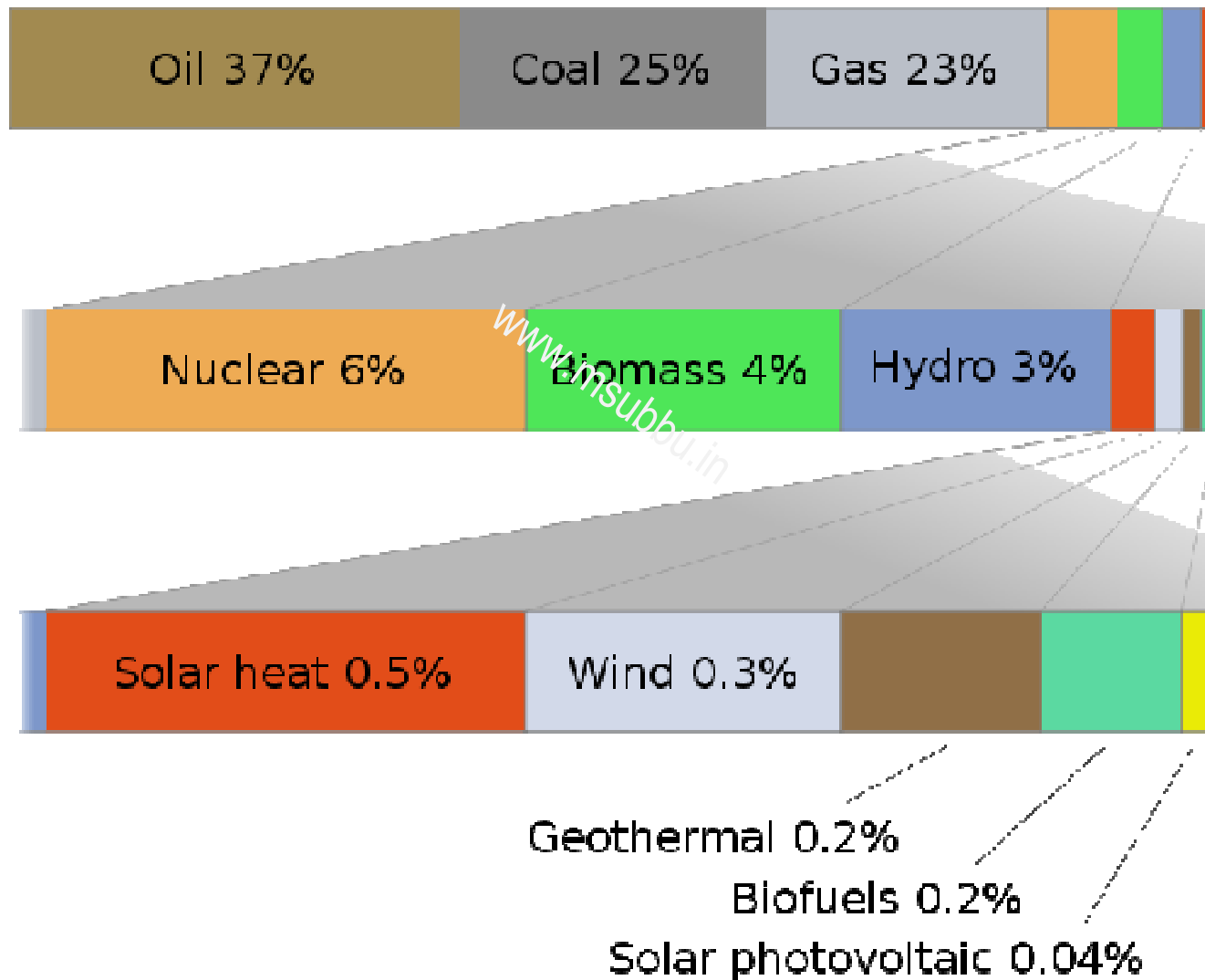
- The world average energy consumption per person is equivalent to 2.2 ton of coal per year (\sim 1 ton of oil)
- In industrialized countries people use four to five time more than the world average
- An American uses 32 times more commercial energy than an Indian

Rate of world energy usage in terawatts (TW) (1965-2005)

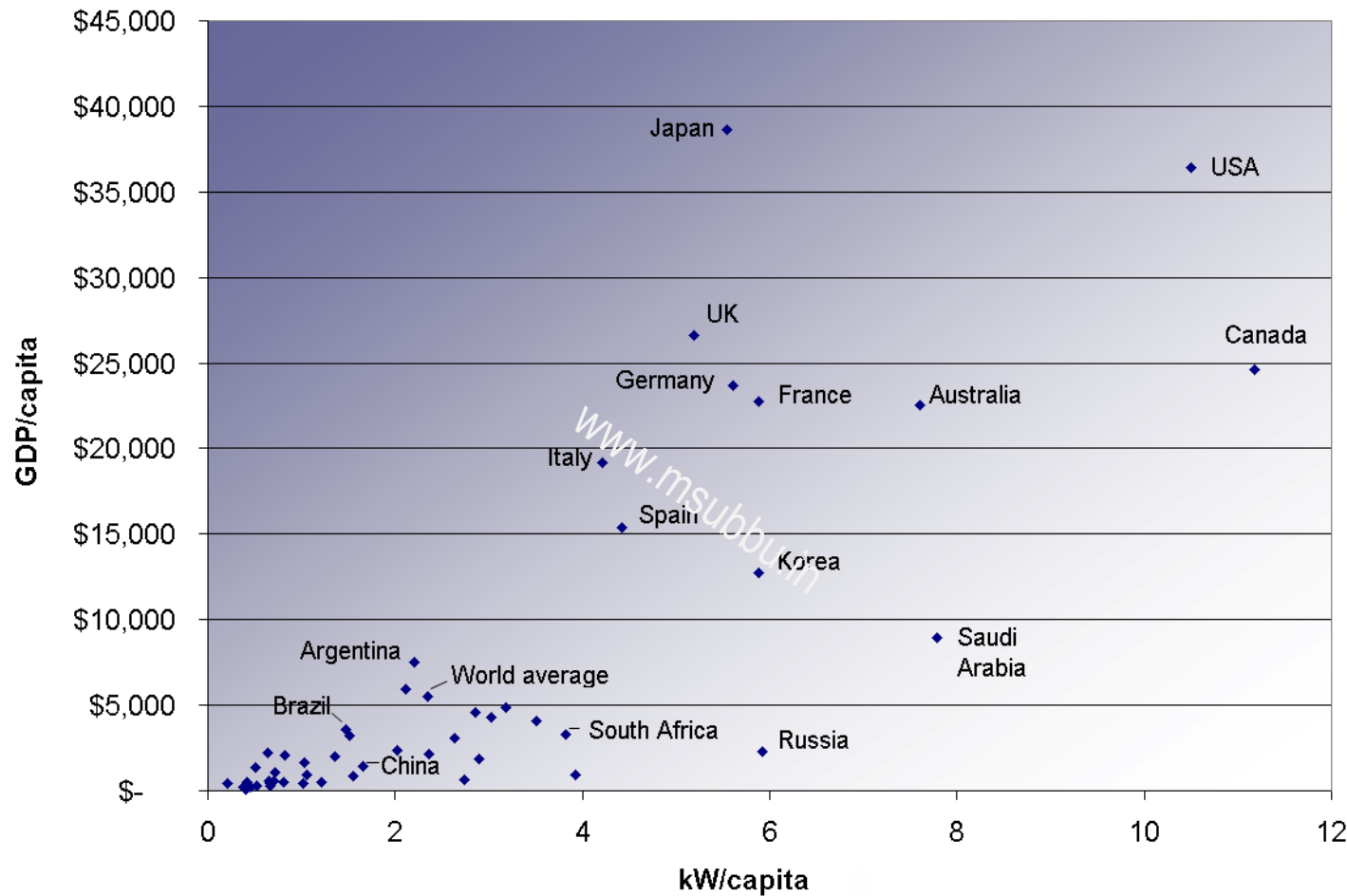


Global energy consumption rate (2006): 16 TW

Global Energy Usage (2006)



Energy Consumption Per capita (GNP) (2004)



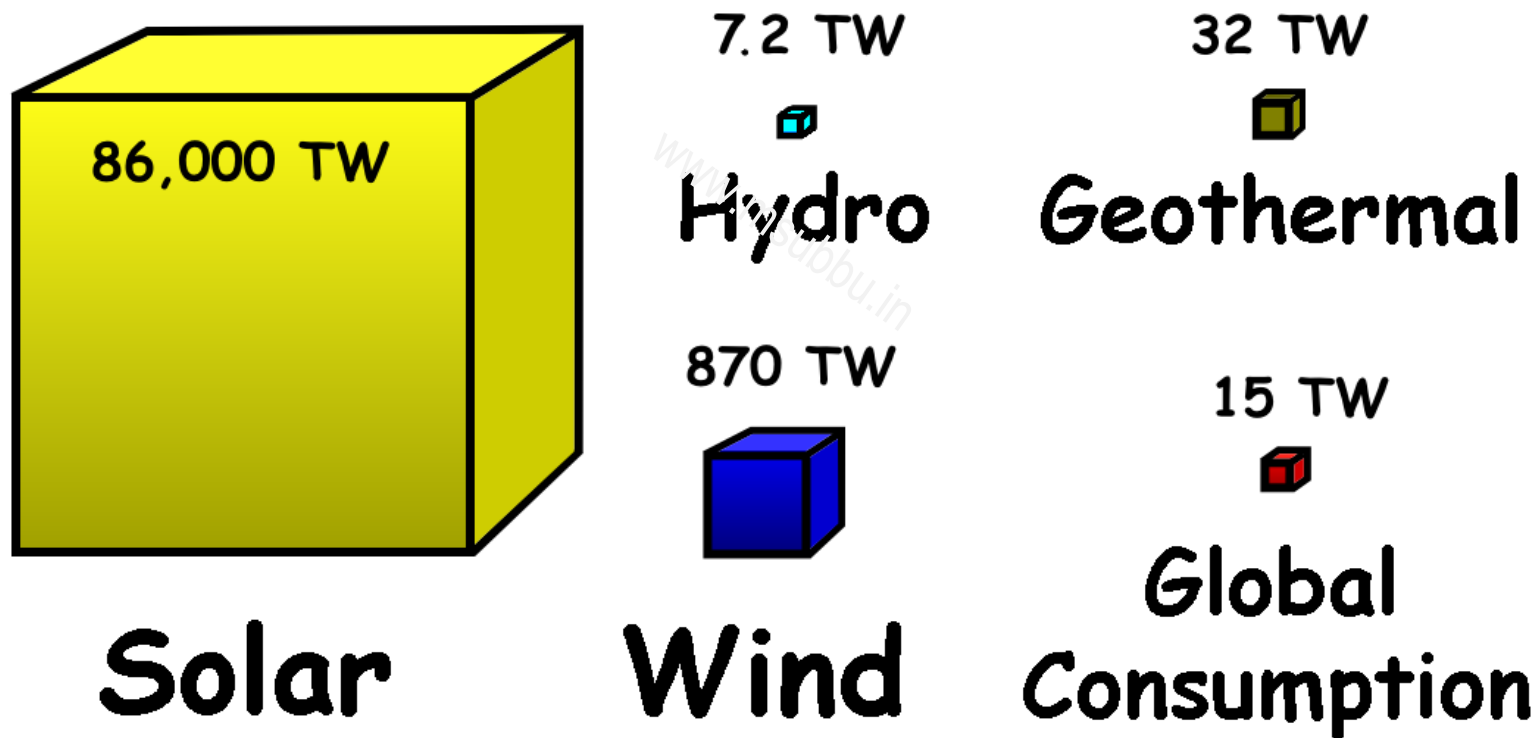
•India: 0.7 kW; Bangladesh: 0.2 kW (least)

•The US consumes 25% of the world's energy (with a share of the world population at 5%).

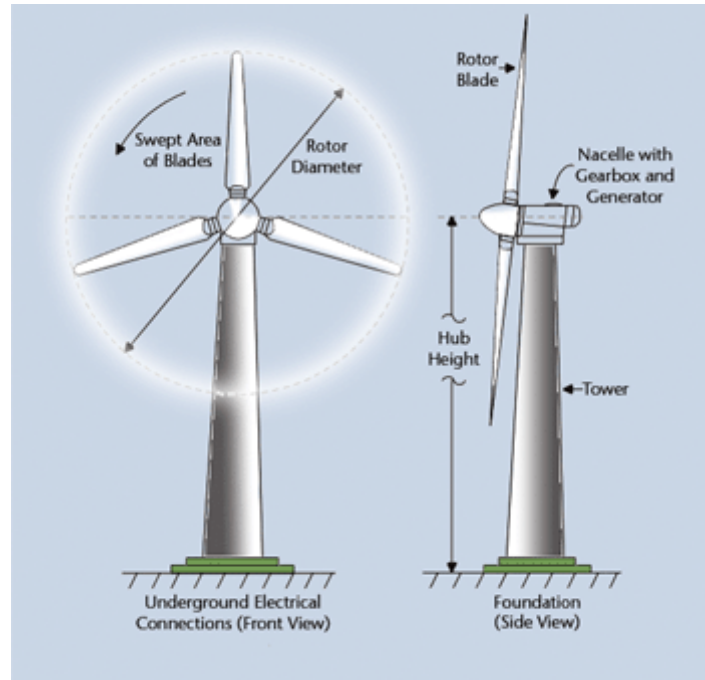
Energy Use by Sector

Industry (agriculture, mining, manufacturing, and construction)	37%
Personal and commercial transportation	20%
Residential heating, lighting, and appliances	11%
Commercial uses (lighting, heating and cooling of commercial buildings, and provision of water and sewer services)	5%
Energy losses in generation and transmission	27%

Available Renewable Energy



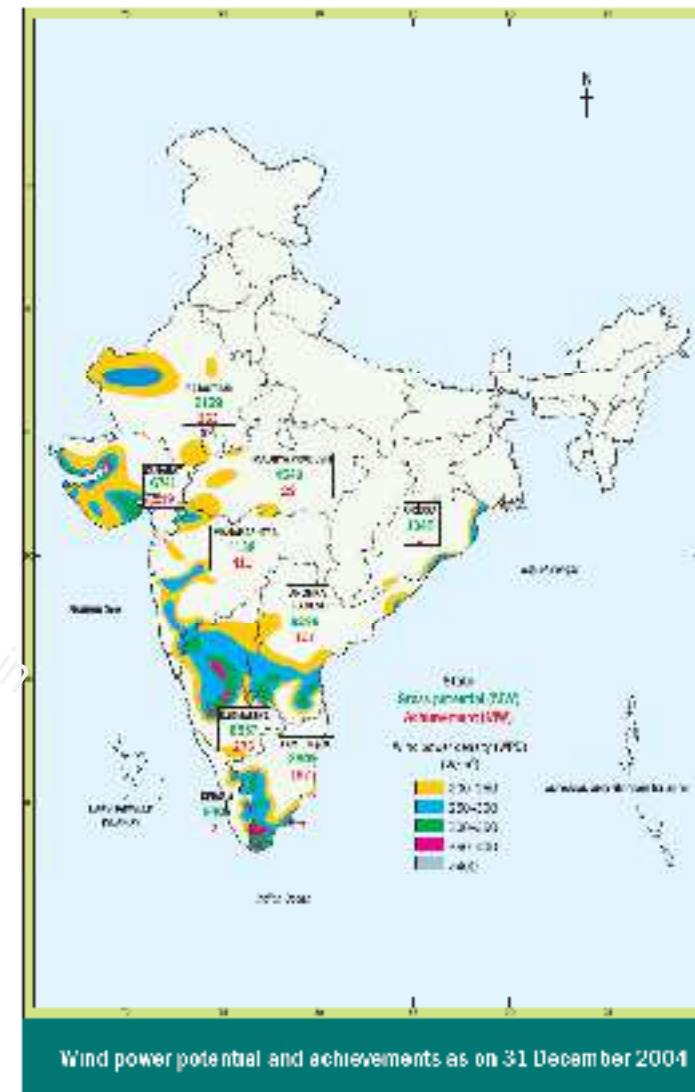
Wind Energy



Wind Power in India

Wind power generation in
India during 2006-07: 1.1 GW

Estimated wind power
potential of India: 20 GW



Wind power density map

Nuclear Power Plants in India

Currently producing:

Power station	State	Units	Total capacity (MW)
Kaiga	Karnataka	220 x 3	660
Kakrapar	Gujarat	220 x 2	440
Kalpakkam	Tamil Nadu	220 x 2	440
Narora	Uttar Pradesh	220 x 2	440
Rawatbhata	Rajasthan	100 x 1, 200 x 1, 220 x 2	740
Tarapur	Maharashtra	160 x 2, 540 x 2	1400
Total		17	4120

Under construction (6 units) : 3160 MW

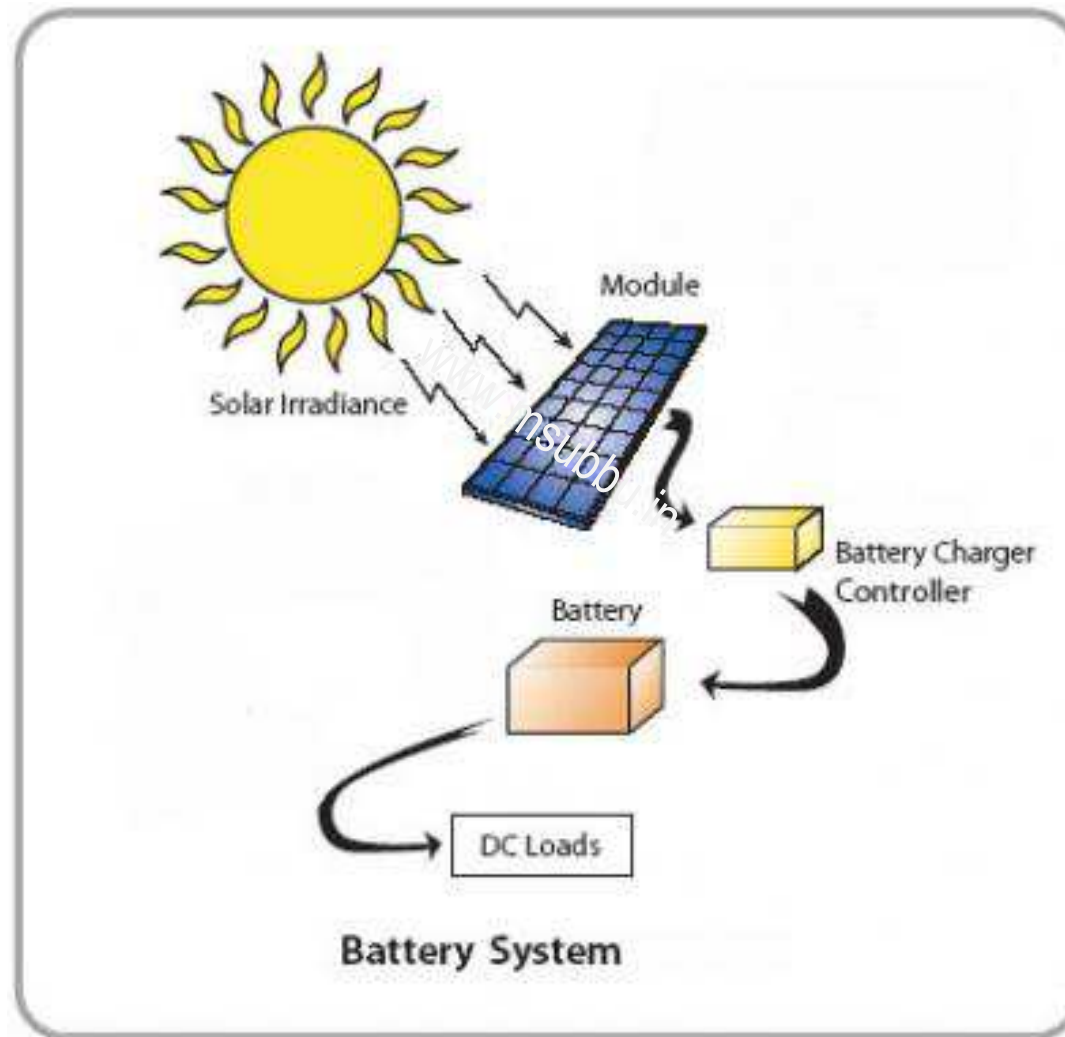
Planned (10 units) : 20,600 MW

Target: 20 GW, by the year 2020



Source: http://en.wikipedia.org/wiki/Template:India_nuke_plant_map (28-May-2009)

Solar Power



Geothermal Energy

Schematic of binary cycle geothermal power plant

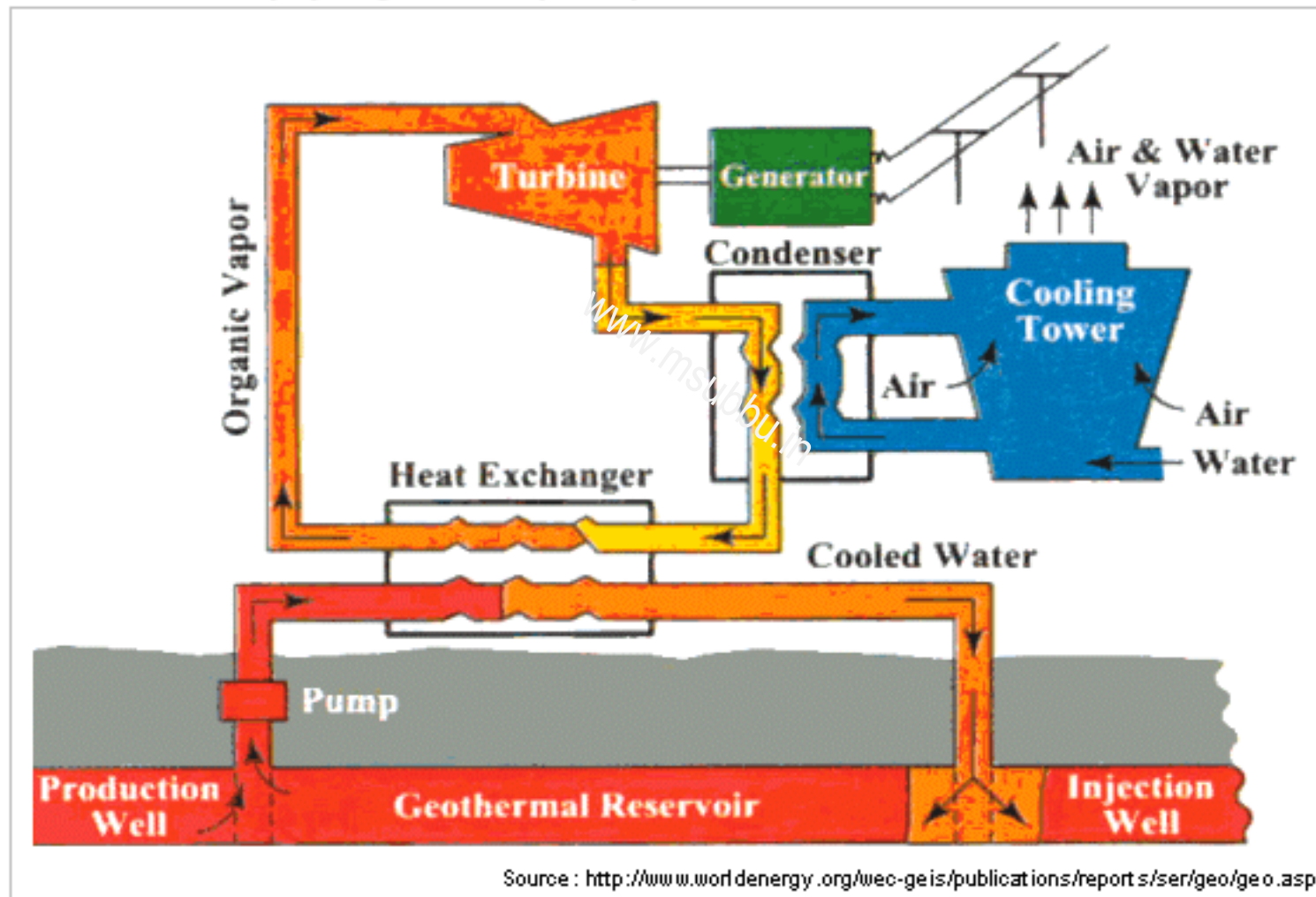
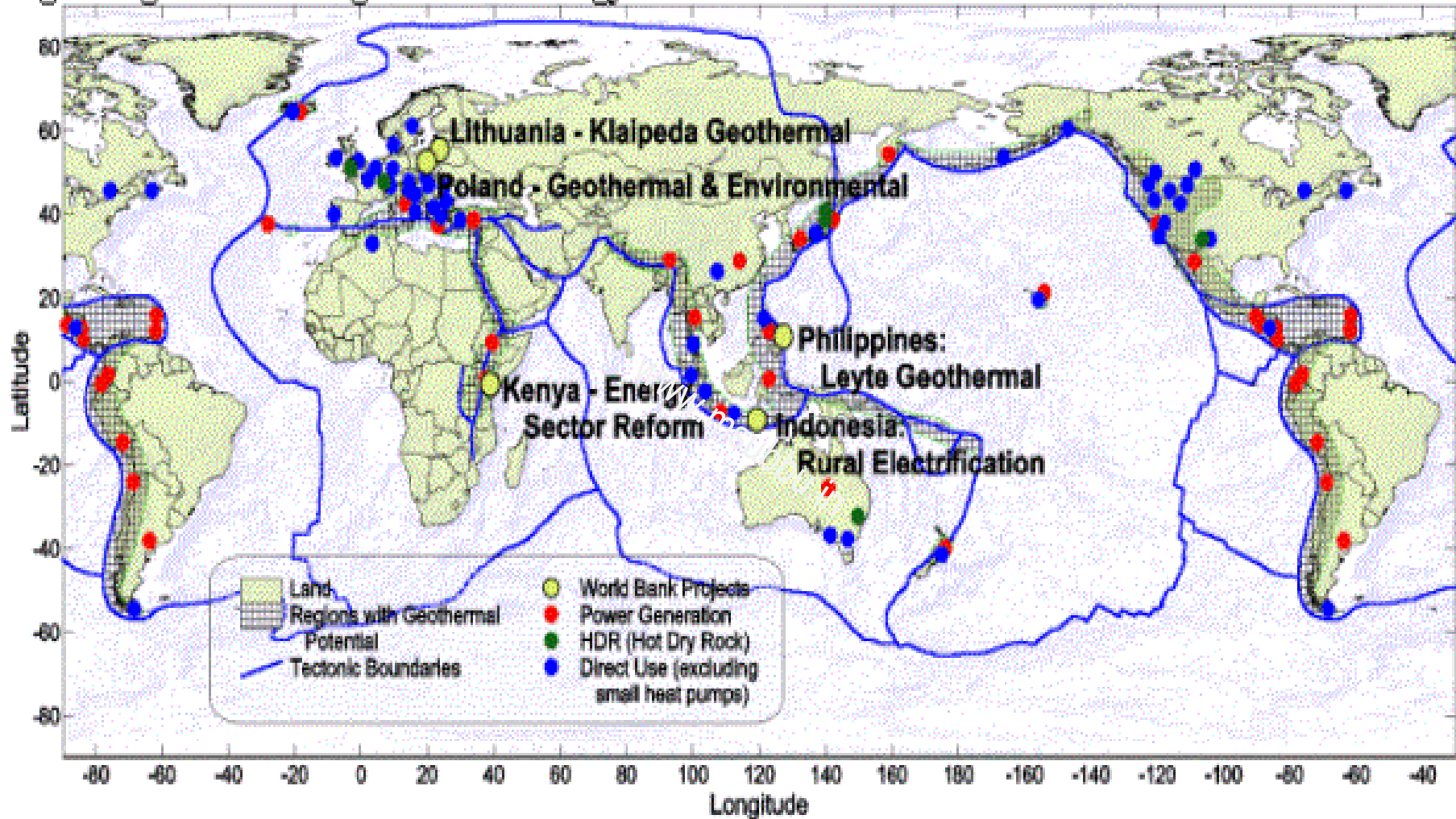


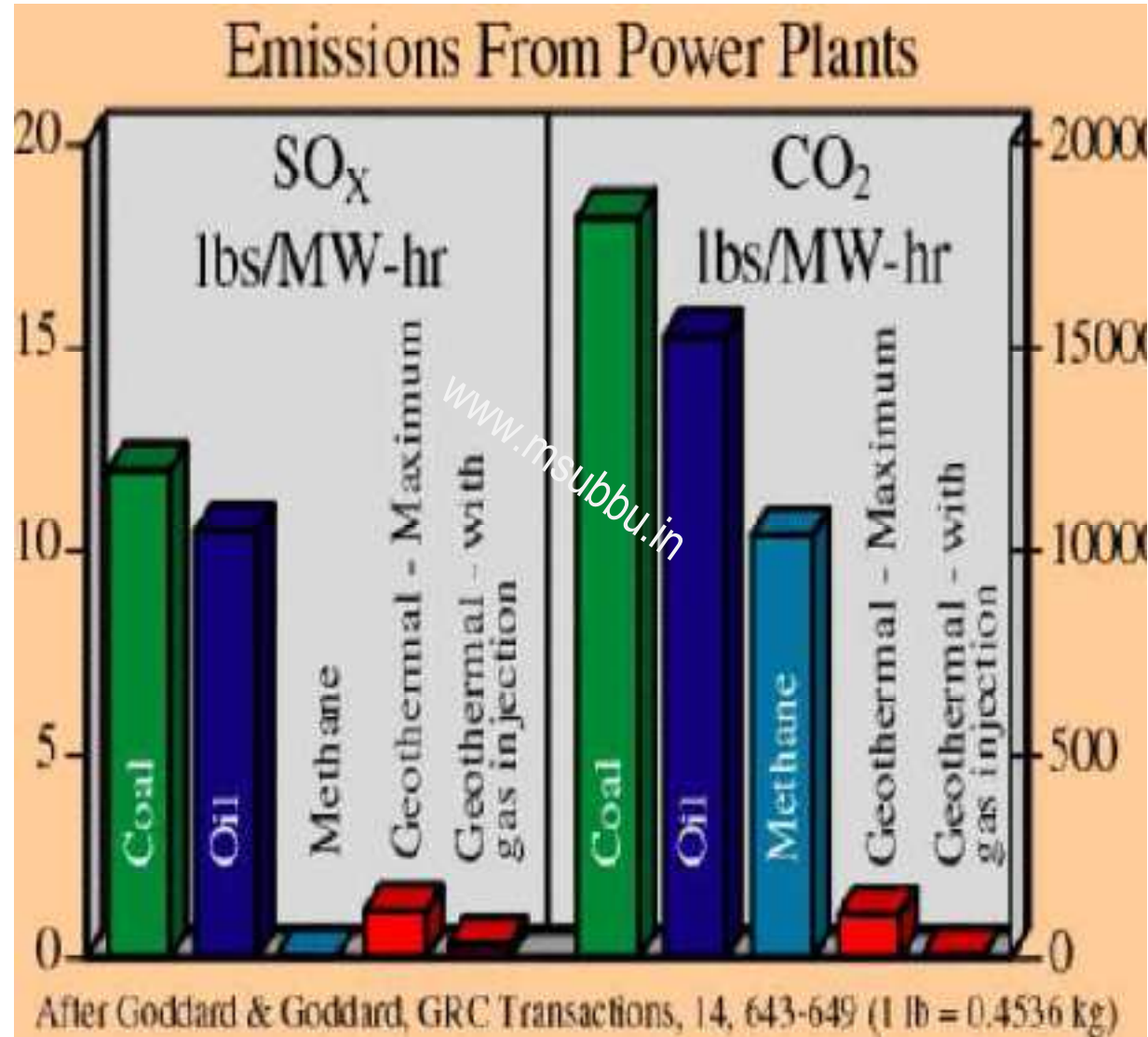
Figure a global view of geothermal energy



Geothermal Power - Status

- USA, Philippines, Italy, Mexico, Iceland Indonesia, Japan and New Zealand are the largest users of geothermal energy resources
- Currently there are an estimated 12,000 MW of direct use and over 8,000 MW of generating capacity in geothermal resources world-wide.
- To put geothermal generation into perspective, this generating capacity is about 0.4% of the World total installed generating capacity

CO₂ Emissions



Environmental Impacts of Energy Production

- The amount of energy consumed per capita – standard of living. Demand for energy increases accordingly
- Most of our energy is currently produced from fossil fuels – increase of CO₂ production
- Increase of CO₂ – global warming, climate changes
- Current reserves of fossil fuels: Oil - 40 years, Gas - 70 years,
Coal - 250 years
- The alternatives are expensive at present – little economic incentive to reduce consumption of fossil fuels

Environmental Impacts of Energy Production (contd.)

- Production and consumption of almost any type of energy have environmental impacts.
- Harvesting of fuel-wood, in particular, contributes to deforestation, soil erosion, and desertification.
- Use of fuel-wood as an energy source can also contribute to the accumulation of CO₂, the main greenhouse gas, both because burning fuel-wood produces CO₂, and because deforestation destroys an important CO₂ sink.
- Use of biomass in traditional stoves exposes the users, mainly women and children, to high levels of indoor air pollution.
- The environmental consequences of energy production and use also adds on to waste management.

CO₂ Release due to Fossil Fuel Consumption

- Global combustion of fossil fuels and other materials places almost 7 billion tons of carbon, in the form of carbon dioxide (CO₂), into the atmosphere each year.
- On average, Earth's oceans, trees, plants and soils absorb about one-half of this carbon. The balance remains in the air and is responsible for the annual increase.

Tracking CO₂ levels

- Each year since global measurements of CO₂ began, the amount of carbon dioxide in the atmosphere has increased.
- Scientific measurements of levels of CO₂ contained in cylinders of ice, called ice cores, indicate that the pre-industrial carbon dioxide level was 278 ppm. That level did not vary more than 7 ppm during the 800 years between 1000 and 1800 A.D.
- Atmospheric CO₂ levels have increased from about 315 ppm in 1958 to 378 ppm at the end of 2004, which means human activities have increased the concentration of atmospheric CO₂ by 100 ppm or 36 percent.

