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UNIT – I
Principles of Sustainable Development

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In the last half of the twentieth century, four key themes emerged from the collective concerns and aspirations of the people globally: **peace, freedom, development, and environment**.

The peace that was thought to be finally secured after the 2nd world war (1941-1944) was immediately threatened by the nuclear arms race.

Throughout the Cold War, peace was sustained globally but fought locally, often by proxies for the superpowers. While the number of wars has diminished over the last decade, peace is still sought, primarily in Africa and in the Middle East.

The success of many former colonies in attaining national independence was followed by a focus on economic development to provide basic necessities for the poorest two-thirds of the world and higher standards of living.

Finally, it is only in the past 50 years that the environment (local to global) became a key focus of national and international law and institutions.

After the 1972 Stockholm Conference on the Human Environment and the 1980 World Conservation Strategy of the International Union for the Conservation of Nature (IUCN), it was realized that the need to create an organization whose sole purpose was to raise awareness of the need for **sustainable development**.

During this time period, people in developed countries have become more aware about environmental issues stemming from industrialization and growth.

Developed countries wanted to reduce the environmental impact of their growth. On the other hand, developing countries were desperate to use cheap methods with high environmental impact and unethical labour practices in their push to industrialize.

The UN saw a growing need for an organization to address these environmental challenges.

In December 1983, the former Secretary General of the UN, Javier Pérez de Cuéllar, asked the Prime Minister of Norway, Dr. Gro Harlem Brundtland, to create an organization independent of the UN to focus on environmental and developmental problems and solutions after an affirmation by the General Assembly resolution in the fall of 1984.

This new organization, generally known as the Brundtland Commission, or referred more formally as the World Commission on Environment and Development (WCED). The Brundtland Commission was first headed by Gro Harlem Brundtland as Chairman and Mansour Khalid as Vice-Chairman.

Dr.Gro Harlem Brundtland served three terms as the prime minister of Norway from 1981 to 1992, and as the director-general of the World Health Organization (WHO) from 1998 to 2003.

What is SUSTAINABLE DEVELOPMENT?

Sustainable Development

Development that meets the needs of the present without compromising the ability of the future generations to meet their own needs (**World Commission on Environment and Development, 1987**).

Sustainable Development

Balancing the fulfillment of human needs with the protection of the natural environment so that these needs can be met not only in the present, but in the indefinite future

The three main pillars of sustainable development include **economic growth, environmental protection** and **social equality**. While many people agree that each of these three ideas contribute to the overall idea of sustainability, it is difficult to find evidence of equal levels of initiatives for the three pillars in countries' policies worldwide. With the overwhelming number of countries that put economic growth on the forefront of sustainable development, it is evident that the other two pillars have been suffering, especially with the overall well being of the environment in a dangerously unhealthy state.

Implementing sustainable development globally is still a challenge, but because of the Brundtland Commission's efforts, progress has been made. After releasing their report, **Our Common Future** in 1987, the Brundtland Commission called for an international meeting to take place where more concrete initiatives and goals could be mapped out.

This meeting was held in Rio de Janeiro, Brazil. A comprehensive plan of action, known as **Agenda 21**, came out of the meeting. Agenda 21 entailed actions to be taken globally, nationally, and locally in order to make life on Earth more sustainable in the future.

5 Aspects of Sustainable Development

"Meeting the needs of the present" means satisfying

Economical

A. Must be able to produce goods and services on a continuing basis adequate livelihood or productive assets

B. economic security when unemployed, ill, disabled or otherwise unable to secure a livelihood.

Social

C. Gender equity
D. Political accountability
E. Participation

Political

Freedom to participate in national and local politics.

Participation in decisions regarding the management and development of one's home and neighborhood, with respect for civil and political rights and in the implementation of environmental legislation.

Environmental

Must maintain a stable resource base avoiding over exploitation of renewable resource systems and Depleting non-renewable resources.

Cultural

- A means to achieve a more satisfactory intellectual, emotional, moral, and spiritual existence

Meeting such needs "**without undermining the ability of future generations to meet their own needs**" means:

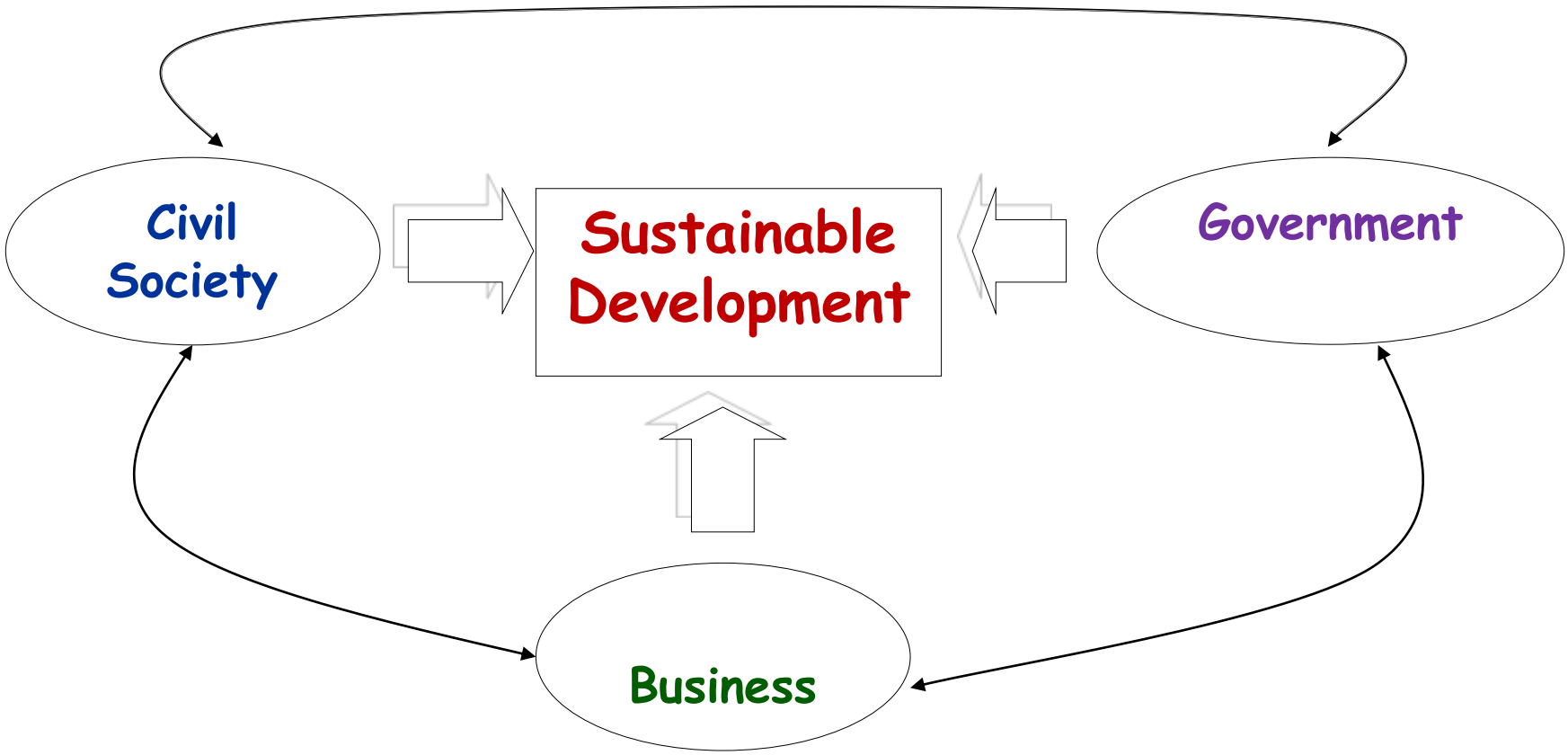
- Minimizing use or waste of non-renewable resources (by minimizing the consumption of fossil fuels and substituting with renewable sources where feasible)

- Minimizing the waste (by reducing use, reusing, and recycling).

- Sustainable use of renewable resources (by using freshwater, soils, and forests in ways that ensure a natural rate of recharge).

- Keeping within the absorptive capacity of local and global sinks of wastes --- including the capacity of rivers to break down biodegradable wastes as well as the capacity of global environmental systems, such as climate, to absorb greenhouse gases.

Key Actors in Sustainable Development



Business

Key actor in the realm of economy

The central social concern and process is the mutually beneficial production and distribution of goods and services to meet the physical needs of human beings.

Government

Key actor in the realm of polity

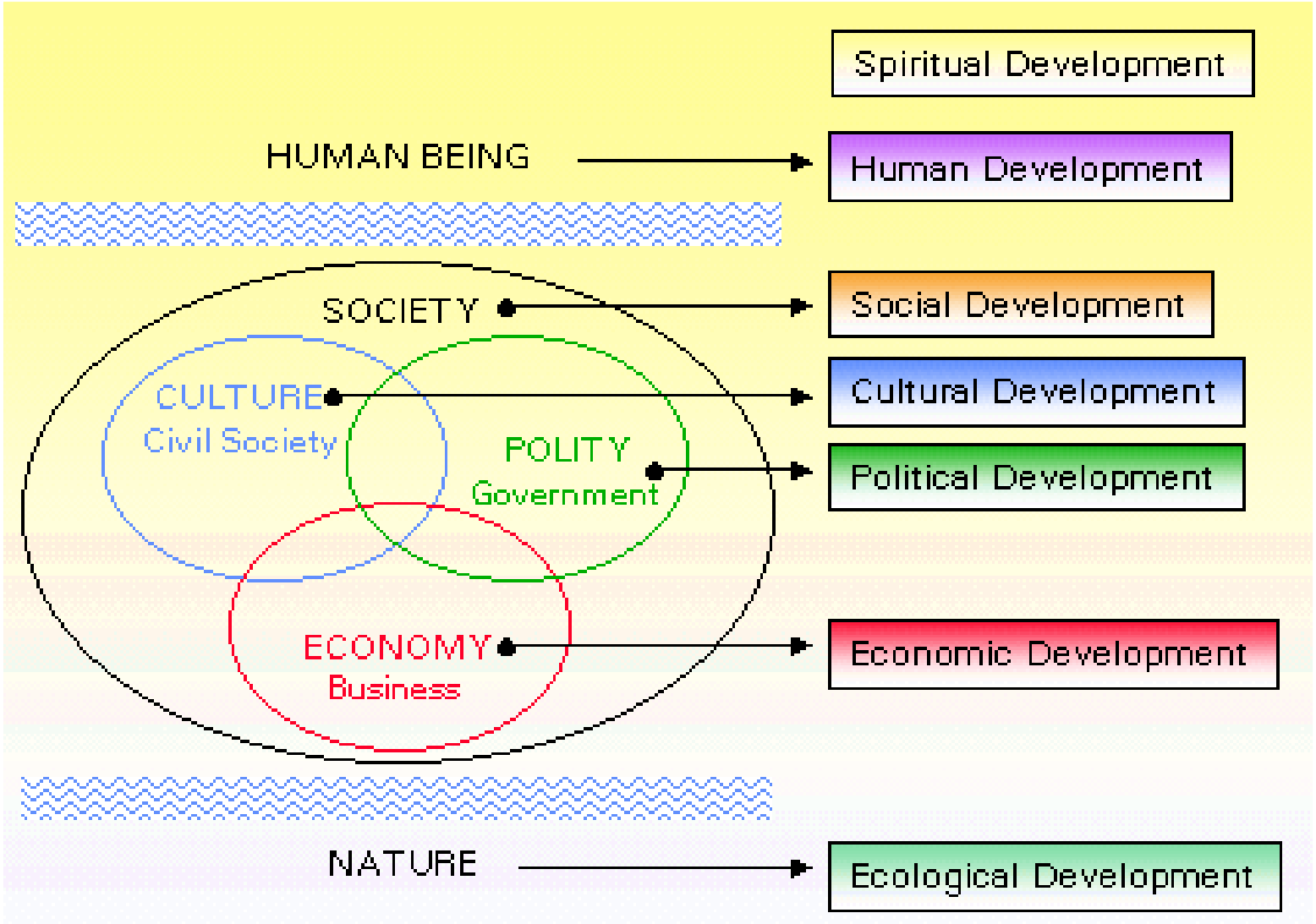
The central social concern and process is participatory, democratic governance and rule making to secure the human rights of all citizens including justice and equity.

Civil Society

Key actor in the realm of culture

The central social concern and process is the development of the social and spiritual capacities of human beings in order, among others, to advance the frontiers of knowledge, to achieve clarity and coherence of values and to advocate the public interest.

7 Dimensions of Sustainable Development



Principles of Sustainable Development

1. **Primacy of Developing Full Human Potential** – people are at the core of development initiatives

2. **Wholistic Science and Appropriate Technology** – the search for solutions to the complex milieu of development problems has to be undertaken with the perspective that situates specific problems in the larger social and ecological context.

Principles of Sustainable Development

3. **Cultural, Moral and Spiritual Sensitivity** - nurturing the inherent strengths of local and indigenous knowledge, practices and beliefs while respecting the cultural diversity, moral norms and spiritual essence of Filipino society

4. **Self-determination** – Respecting the right and relying on the inherent capacity of the country and its people to decide on the course of their own development

5. **National Sovereignty** – self-determination at the national level where the norms of society and the specifics of the local ecology inform national governance. Includes human and environmental security as well as achieving and ensuring security and self-reliance in basic staple foods.

6. Gender Sensitivity – recognizing the important and complementary roles and the empowerment of both men and women in development

7. Peace, Order and National Unity – securing the right of all to a peaceful and secure existence

8. Social Justice, Inter-, Intra-Generational and Spatial Equity – ensuring social cohesion and harmony through equitable distribution of resources and providing the various sectors of society with equal access to development opportunities and benefits today and in the future.

9. **Participatory Democracy** - ensuring the participation and empowerment of all sectors of society in development decision-making and processes and to operationalize intersectoral and multisectoral consensus

10. **Institutional Viability** - recognizing that sustainable development is a shared, collective and indivisible responsibility which calls for institutional structures that are built around the spirit of solidarity, convergence and partnership between and among different stakeholders.

11. Viable, sound and broad-based economic development - development founded on a stable economy where the benefits of economic progress are equitably shared across ages, communities, gender, social classes, ethnicities, geographical units and across generations.

12. Sustainable Population - achieving a sustainable population level, structure and distribution while taking cognizance of the limited carrying capacity of nature and the interweaving forces of population, culture, resources, environment and development.

13. Ecological Soundness - recognizing nature as our common heritage and thus respecting the limited carrying capacity and integrity of nature in the development process to ensure the right of present and future generations to this heritage.

14. Biographical Equity and Community - Based Resource Management - recognizing that since communities residing within or most proximate to an ecosystem of a bio-geographic region will be the ones to most directly and immediately feel the positive and negative impacts on that ecosystem, they should be given prior claim to the development decisions affecting that ecosystem including management of the resources.

15. Global Cooperation - building upon and contributing to the diverse capacities of individual nations.

Conclusion:

- Sustainable Development is a relevant concept in the process of socio-economic and political growth in the modern society.

- Trinitarian approach to development – the key actors are not only coming from the government sector but also the process of socio-economic and political development must be shared by the business and civil society respectively.

Natural resources are derived from the environment. Some of them are essential for our survival while most are used for satisfying our wants. Natural resources can be classified in different ways.

Natural resources are materials and components (something that can be used) that can be found within the environment. Every man-made product is composed of natural resources.

A natural resource may exist as a separate entity such as fresh water, and air, as well as a living organism such as a fish, or it may exist in an alternate form which must be processed to obtain the resource such as metal ores, oil, and most forms of energy.

Some natural resources can be found everywhere such as sunlight and air, when it is so the resource is known as an **ubiquitous** (existing or being everywhere) resource. However most resources are not ubiquitous. They only occur in small sporadic areas; these resources are referred to as **localized** resources.

There are very few resources that are considered inexhaustible (will not run out in foreseeable future) – these are solar radiation, geothermal energy, and air (though access to clean air may not be).

The vast majority of resources are however exhaustible, which means they have a finite quantity, and can be depleted, if managed improperly.

The natural resources are materials, which living organisms can take from nature for sustaining their life or any components of the natural environment that can be utilized by man to promote his welfare is considered to be natural resources.

Classification

There are various methods of categorizing natural resources, these include source of origin, stage of development, and by their renewability. On the basis of origin, resources may be divided into:

Biotic – Biotic resources are obtained from the biosphere (living and organic material), such as forests and animals, and the materials that can be obtained from them. Fossil fuels such as coal and petroleum are also included in this category because they are formed from decayed organic matter.

Abiotic – Abiotic resources are those that come from non-living, non-organic material. Examples of abiotic resources include land, fresh water, air and metals including ores such as gold, iron, copper, silver, etc.

Renewability is a very popular topic and many natural resources can be categorized as either **renewable** or **non-renewable**.

Renewable resources are ones that can be replenished naturally. Some of these resources, like sunlight, air, wind, etc., are continuously available and their quantity is not noticeably affected by human consumption. Though many renewable resources do not have such a rapid recovery rate, these resources are susceptible to depletion by over-use. Resources from a human use perspective are classified as renewable only so long as the rate of replenishment/recovery exceeds that of the rate of consumption.

Non-renewable resources are resources that form extremely slowly and those that do not naturally form in the environment. Minerals are the most common resource included in this category. By the human perspective, resources are non-renewable when their rate of consumption exceeds the rate of replenishment/recovery; Ex. fossil fuels, which are in this category because their rate of formation is extremely slow (potentially millions of years), meaning they are considered non-renewable.

In recent years, the depletion of natural resources has become a major focus of governments and organizations such as the United Nations (UN). UN's Agenda 21 Section 2 outlines the necessary steps to be taken by countries to sustain their natural resources.

In regards to natural resources, depletion is of concern for sustainable development as it has the ability to degrade current environment and has potential to impact the needs of future generations.

Depletion of Natural Resources is associated with social inequity. Considering most biodiversity are located in developing countries, depletion of this resource could result in losses of ecosystem for these countries. Some view this depletion as a major source of social unrest and conflicts in developing nations.

Natural Resource Management (NRM) focuses on the management of natural resources such as land, water, soil, plants and animals, with a particular focus on how management affects the quality of life for both for present and future generations.

Management of natural resources involves identifying who has the right to use the resources and who does not for defining the boundaries of the resource. The resources are managed by the users according to the rules governing of when and how the resource is used depending on local condition.

A successful management of natural resources should engage the community because of the nature of the shared resources the individuals who are affected by the rules can participate in setting or changing them. The users have the rights to device their own management institutions and plans under the recognition by the government.

Natural Resources Inventory

A Natural Resources Inventory is a document that inventories the natural resources of an area, collects the data in a usable format and interprets the findings. While an inventory of a single parcel of land might be quite specific and detailed, a state / region wide Natural Resources Inventory is, by necessity, more generalized.

The primary purpose of this Natural Resources Inventory is to provide data that can form a basis for planning; it provides basic data for the preparation of plans, information to review proposed development plans, and data to assist in completing environmental assessment forms.

Minerals are valuable natural resources being finite and non-renewable. They constitute the vital raw materials for many basic industries and are a major resource for development. Management of mineral resources has, therefore, to be closely integrated with the overall strategy of development; and exploitation of minerals is to be guided by long-term national goals and perspectives.

In this context the need has been felt to spell out in a statement the different elements of the policy, which has evolved over the years, relating to development of our mineral resources and in regard to areas of concern which have emerged in recent years.

If a country is not endowed with all the requisite mineral resources, it is imperative to achieve the best use of available mineral resources through scientific methods of mining, beneficiation and economic utilization.

Simultaneously, it is essential to keep in view the present and future needs of defense and development of the country and strive to ensure indigenous availability of basic and strategic minerals to avoid disruption of core industrial production in times of international strife.

These aspects constitute the essentials of **National Mineral Policy** which has evolved over the years.

The policy also emphasizes certain new aspects and elements like

- mineral exploration in the sea-bed
- development of proper inventory
- proper linkage between exploitation of minerals and development of mineral industry
- protection of forest, environment and ecology from the adverse effects of mining
- enforcement of mining plan for adoption of proper mining methods and
- optimum utilization of minerals, export of minerals in value added form and recycling of metallic scrap and mineral waste.

REGULATION OF MINERALS

Management of mineral resources is the responsibility of the Central Government and the State Governments in terms of Entry 54 of the Union List (List I) and Entry 23 of the State List (List II) of the Seventh Schedule of the Constitution of India.

The Mines and Minerals (Regulation and Development) Act, 1957 lays down the legal frame-work for the regulation of mines and development of all minerals other than petroleum and natural gas. The Central Government have framed the Mineral Concession Rules 1960 for regulating grant of prospecting licenses and mining leases in respect of all minerals other than atomic minerals and minor minerals.

The State Governments have framed the rules in regard to minor minerals. The Central Government have also framed the Mineral Conservation and Development Rules, 1988 for conservation and systematic development of minerals. These are applicable to all minerals except coal, atomic minerals and minor minerals.

The Central Government in consultation with the State Governments, shall continue to formulate the legal measures for the regulation of mines and the development of mineral resources to ensure basic uniformity in mineral administration and to ensure that the development of mineral resources keeps pace, and is in consonance with the national policy goals.

The regulation of mines and development of mineral resources in accordance with the national goals and priorities shall be the responsibility of the Central and State Governments.

SURVEY AND EXPLORATION

The Geological Survey of India is the principal agency for geological mapping and regional mineral resources assessment in our country and its exclusive economic zone and is also responsible for drawing up action oriented plans in close co-operation with all other agencies engaged in this task.

The Department of Ocean Development and its agencies are entrusted with the task of sea-bed exploration, exploitation, mining and processing.

Detailed survey and exploration on land is done by Mineral Exploration Corporation, Directorates of Mining and Geology of the State Governments and various Central and State Public Sector Organisations. The initiative and co-operation of the private sector will also be drawn upon as required.

STRATEGY OF MINERAL DEVELOPMENT

The Strategy for development of any mineral should naturally keep in view its ultimate end uses.

As minerals are exhaustible and non-renewable resources, their exploitation has to be done keeping in view not only the present but the long term needs. The strategy for exploitation and development of each mineral shall be formulated and reviewed periodically on the basis of available resources. A thrust is to be given to exploitation of mineral resources in which the country is well endowed so that industries based on these resources can come up to meet the needs of industrial materials for which we have now to depend on external sources.

An optimal depletion rate shall be worked out in respect of each mineral, keeping in view the domestic and global resource position, the international market situation and the needs for stable and sustained economic development.

Mineral Development & Protection of Environment

Extraction and development of minerals are closely interlinked with other natural resources like land, water, air and forest. The areas in which minerals occur often have other resources and are ecologically fragile and some are biologically rich. It is necessary to take comprehensive view to the needs of development as well as needs of protecting the environment and ecology. Both aspects have to be properly coordinated to facilitate and ensure a sustainable development of mineral resources in harmony with environment.

Mining activity often leads to environmental problems like land degradation particularly in opencast mining, land subsidence in underground mining, deforestation, atmospheric pollution, pollution of rivers and streams, disposal of solid wastes, etc. affecting the ecological balance of the area.

Prevention and mitigation of adverse environmental effects due to mining and processing of minerals and repairing and revegetation of the affected forest area and land covered by trees in accordance with the prescribed norms and established forestry practices shall form integral part of mine development strategy in every instance.

Mining operations shall not ordinarily be taken up in identified ecologically fragile and biologically rich areas. Strip mining in forest areas should as far as possible be avoided and it should be permitted only when accompanied with comprehensive time-bound reclamation programme.

No mining lease would be granted to any party, private or public, without a proper mining plan including the environmental management plan approved and enforced by statutory authorities. The environmental management plan should adequately provide for controlling the environmental damage, restoration of mined areas and for planting of trees according to the prescribed norms. As far as possible, reclamation and afforestation will proceed concurrently with mineral extraction.

Mineral wealth is finite and non-renewable. It is a major resource for development. The management of this precious resource and its optimal and economical use are matters of national importance.

India is rich in mineral resources and is a leading producer of key minerals like iron ore and bauxite. However, the mining sector's share of GDP of the country's continues to fall, from 2.3% in 2004-2005, it declined to 1.93 % in 2012-13 and further fell to 1.53 % in 2017-18 (excluding petroleum & natural gas). GDP from Mining in India decreased to 916.91 INR Billion in the second quarter of 2024 from 1004.93 INR Billion in the first quarter of 2024. GDP from Mining in India averaged 766.25 INR Billion from 2011 until 2024, reaching an all time high of 1056.74 INR Billion in the first quarter of 2017 and a record low of 556.18 INR Billion in the third quarter of 2012. source: Ministry of Statistics and Programme Implementation (MOSPI).

Exhibit 1: India–R/P ratio of minerals in India

Mineral	Production*	Proven reserves*	R/P ratio	Total resources*	Proven reserves/ Total resource ratio
Iron ore (million tonnes)	213	4960	23.3	25,250	0.20
Coal (million tonnes)	537	113,408	211.2	284,370	0.40
Bauxite (million tonnes)	13.4	539	40.2	3,290	0.16
Gold (kg)	2,214	66,920	30.23	490,810	0.14
Diamond (carats)	71,381	605,577	8.48		0.13
Silver metal (tonnes)	95**	2,283	24.03	10,213	0.22
Zinc and lead metal ('000 tonnes)	794	6,766	8.52	31,467	0.22
Copper metal ('000 tonnes)	721**	1,644	2.28	11,418	0.14

Source: Ministry of Mines FY11 annual report; Indian Minerals Year Book (Advance release) 2009, "The Indian Copper Industry," ICRA Management Consultancy Services Limited, August 2010, via Thomson Research , Ministry of Coal website, Ernst & Young analysis

* Production numbers are estimated of 2010-11; Reserves and resources are as on April 2005, in accordance with the National Mineral Inventory

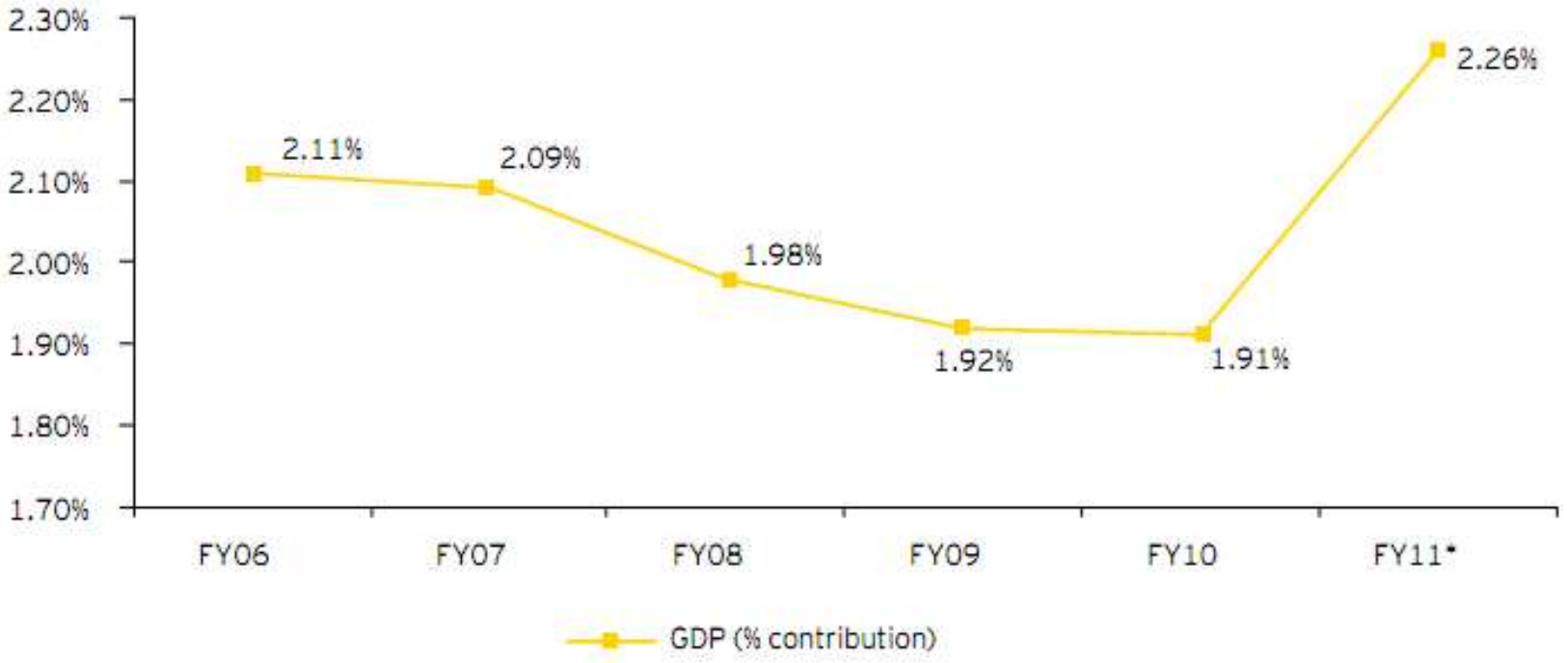
**Silver and copper production numbers are those of 2009

Top 10 countries with the most valuable natural resource reserves by total estimated value as of 2021, according to Statista

Top Mining Countries in the World, 2024

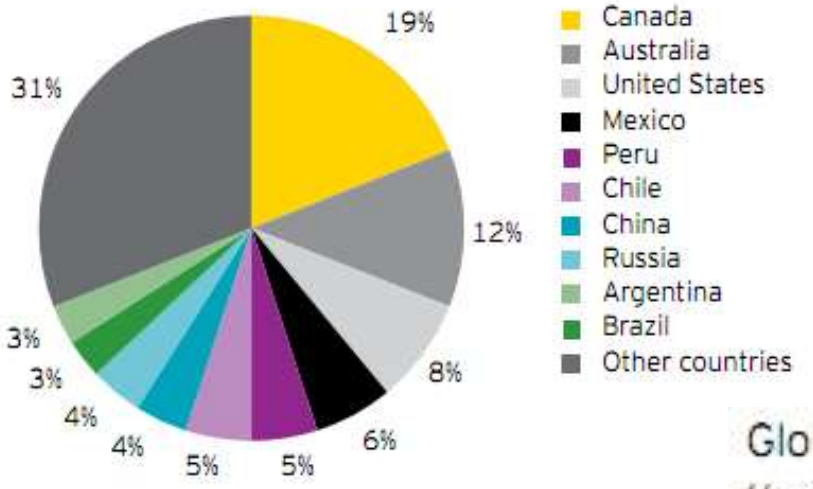
Australia	World's top mining nation. largest producer of bauxite, iron ore and lithium and a top global producer of coal, aluminum, copper, gold, manganese, nickel, silver, uranium, and zinc.
Chile	World's largest copper producer and crucial lithium supplier. The mining sector accounts for over 14% of its GDP. home to around half the world's lithium reserves and a quarter of global copper reserves.
China	World leader in Rare Earth Elements (REE) - over 60% global market share. World's largest producer of coal, gold, antimony, magnesium, tin, zinc, manganese and tungsten.
Russia	Russia has world-class reserves of timber, gold, iron ore, aluminum, nickel, copper, coal, oil and natural gas. Russia vies with Australia for second place in global gold production after China. It is among the top three nickel, platinum and palladium producers as well.
Canada	Ranks among the top five worldwide producers of potash, uranium, cobalt, aluminum, tungsten, platinum group metals, salt, titanium concentrate, and diamonds. Canada's immense geology hosts abundant deposits of gold, silver, nickel, copper, cobalt, graphite, lithium, rare earths and more.
Democratic Republic of Congo (DRC)	The DRC holds over 70% of global cobalt reserves, boasts rich diamond deposits and has bountiful reserves of copper, tin, tantalum, tungsten and gold.
Brazil	world's largest niobium, third-largest bauxite and third-highest iron ore reserves globally. top producer of gold, tin, lithium, nickel, gemstones and other minerals as well.
USA	globally leading producer of copper, gold, molybdenum, phosphate rock, rare earths, salt, soda ash, zeolites and zinc. The mining industry contributed $110 billion to its GDP in 2022.

Mining industry's contribution to GDP (in %)



Source: Ministry of Mines annual report FY11
* In FY11, the base year was changed from 1999-2000 to 2004-05.

Exhibit 7. Exploration budget for the top ten countries, 2010



Source: Metals Economic Group website

Globally, the top 10 countries accounted for 69% of the global exploration budget. In 2010, Canada and Australia were the two leading countries in terms of their share in the global exploration expenditure, with Canada's lead over Australia increasing from about US$220 million in 2009 to US$770 million in 2010. Emerging economies such as China, Brazil and Russia also featured among the leading 10 countries in the global exploration budget, with shares of 4%, 3% and 4%, respectively. Recent trends indicate that China's exploration spend is continuously increasing, with allocation to exploration outside the country rising rapidly. In 2010, Africa attracted even more exploration funds than Australia.

India's share in the global exploration budget continues to be negligible at less than 0.5%. Government entity, the Geological Survey of India (GSI), along with a few other organizations that have limited budgetary support, conduct major regional prospecting and grass root-level field exploration in the country. As a result, based on various reports, suitable regional exploration has taken place at only 8%-13% of areas, way below that of mining majors such as Australia. Most areas in India are yet to undergo geophysical mapping and geo-chemical surveys.

NATIONAL INVENTORY OF MINERAL RESOURCES

The national inventory of mineral resources including those of ocean bed will be based on a comprehensive review of exploration data. These along with the relevant geological data and mineral maps shall be maintained and updated from time to time by the Indian Bureau of Mines as per the uses and specifications in industrial and other applications.

The Indian Bureau of Mines shall continue to compile and provide access to the latest information in respect of mineral resources in the country available for exploitation and endeavour to convert the physical inventory of mineral resources into resource inventory.

A periodical review of the system of classification of inventory of mineral resources shall be carried out incorporating the changes in their industrial and other applications. The grades of various minerals shall be standardized with reference to end use applications and periodically reviewed.

STRATEGY OF MINERAL DEVELOPMENT

1. Conservation and Mineral Development

1.1. The Strategy for development of any mineral should naturally keep in view its ultimate end uses. The guiding principle in the strategy of development of any mineral or mineral deposit at any location shall ordinarily be the economic cost. The State may, however, undertake the development of any mineral or mineral deposit in public interest to ensure unhindered availability of mineral raw material for the realisation of national goals.

1.2. As minerals are exhaustible and non-renewable resources, their exploitation has to be done keeping in view not only the present but the long term needs. The strategy for exploitation and development of each mineral shall be formulated and reviewed periodically on the basis of available resources. A thrust is to be given to exploitation of mineral resources in which the country is well endowed so that industries based on these resources can come up to meet the needs of industrial materials for which we have now to depend on external sources. **An optimal depletion rate shall be worked out in respect of each mineral, keeping in view the domestic and global resource position, the international market situation and the needs for stable and sustained economic development.**

2.0 Scientific Methods of Exploitation

Mine development and mineral conservation as governed by the rules and regulations will be on sound scientific basis, with the regulatory agencies closely interacting with R&D organisation, scientific and professional bodies. Conditions of mining leases regarding tenure, size, shape, disposition with reference to geological boundaries and other mining conditions shall be such as to favourably predispose the leased areas to systematic and complete extraction of minerals.

3.0 Mineral Processing and Beneficiation

Research organisations, including the National Mineral Processing Laboratories of the Indian Bureau of Mines should be strengthened for development of processes for beneficiation and mineral and elemental analysis of ores and ore dressing products. There shall be co-operation between and co-ordination among all organisations in public and private sector engaged in this task.

Recycling of Metallic Scrap and Mineral Wastes

As an important conservation measure, recycling of metallic scrap like steel, copper, aluminium, zinc, lead etc. shall be encouraged and facilitated by fixation of appropriate standards for classification and grading of scrap and adoption of fiscal measures. Similarly, utilisation of low grade minerals, mineral wastes and rejects shall also be encouraged through appropriate incentives.

4.0 Mineral Development & Protection of Environment

4.1 Extraction and development of minerals are closely interlinked with other natural resources like land, water, air and forest. The areas in which minerals occur often have other resources presenting a choice of utilisation of the resources. Some such areas are ecologically fragile and some are biologically rich. It is necessary to take comprehensive view to facilitate the choice or order of land use keeping in view the needs of development as well as needs of protecting the forests, environment and ecology. Both aspects have to be properly coordinated to facilitate and ensure a sustainable development of mineral resources in harmony with environment.

4.2 Mining activity often leads to environmental problems like land degradation particularly in opencast mining, land subsidence in underground mining, deforestation, atmospheric pollution, pollution of rivers and streams, disposal of solid wastes, etc. affecting the ecological balance of the area. Open-cast mining in areas with actual forest cover leads to deforestation. Prevention and mitigation of adverse environmental effects due to mining and processing of minerals and repairing and revegetation of the affected forest area and land covered by trees in accordance with the prescribed norms and established forestry practices shall form integral part of mine development strategy in every instance.

4.3 Mining operations shall not ordinarily be taken up in identified ecologically fragile and biologically rich areas. Strip mining in forest areas should as far as possible be avoided and it should be permitted only when accompanied with comprehensive time-bound reclamation programme.

4.4 No mining lease would be granted to any party, private or public, without a proper mining plan including the environmental management plan approved and enforced by statutory authorities. The environmental management plan should adequately provide for controlling the environmental damage, restoration of mined areas and for planting of trees according to the prescribed norms. As far as possible, reclamation and afforestation will proceed concurrently with mineral extraction.

4.5 Efforts would be made to convert old disused mining sites into forests and other appropriate ecologically safe forms of land use.

Water Resources Development and Management

Water resources

The water cycle, through evaporation and precipitation, maintains hydrological systems which form rivers and lakes and support in a variety of aquatic ecosystems. Wetlands are intermediate forms between terrestrial and aquatic ecosystems and contain species of plants and animals that are highly moisture dependent.

All aquatic ecosystems are used by a large number of people for their daily needs such as drinking water, washing, cooking, watering animals, and irrigating fields. The world depends on a limited quantity of fresh water. Water covers 70% of the earth's surface but only 3% of this is fresh water. Of this, 2% is in polar ice caps and only 1% is usable water in rivers, lakes and subsoil aquifers. Only a fraction of this can be actually used. At a global level 70% of water is used for agriculture about 25% for industry and only 5% for domestic use. However this varies in different countries and industrialized countries use a greater percentage for industry. India uses 90% for agriculture, 7% for industry and 3% for domestic use.

WATER RESOURCES

One of the greatest challenges facing the world in this century is the need to rethink the overall management of water resources. The world population has passed the 6 billion mark. Based on the proportion of young people in developing countries, this will continue to increase significantly during the next few decades. This places enormous demands on the world's limited freshwater supply. The total annual freshwater withdrawals today are estimated at 3800 cubic kilometers, twice as much as just 50 years ago (World Commission on Dams, 2000).

Studies indicate that a person needs a minimum of 20 to 40 liters of water per day for drinking and sanitation. More than one billion people worldwide have no access to clean water, and to many more, supplies are unreliable.

Local conflicts are already spreading to states. Eg. Karnataka and Tamil Nadu over the waters of the river Cauvery.

India is expected to face critical levels of water stress by 2025. At the global level 31 countries are already face water shortage and by 2025 there will be 48 countries in this list.

According to the UN by the year 2050, 4 billion people will be seriously affected by water shortages. This will lead to multiple conflicts between countries over the sharing of water.

There are 100 countries that share the waters of 13 large rivers and lakes. The upstream countries could starve the downstream nations leading to political unstable areas across the world. Examples are Ethiopia, which is upstream on the Nile and Egypt, which is downstream and highly dependent on the Nile. International accords that will look at a fair distribution of water in such areas will become critical to world peace.

India and Bangladesh already have a negotiated agreement on the water use of the Ganges.

Overutilization and pollution of surface and groundwater: With the growth of human population there is an increasing need for larger amounts of water to fulfill a variety of basic needs. Today Overutilization of water occurs at various levels. Most people use more water than they really need. Many agriculturists use more water than necessary to grow crops. There are many ways in which farmers can use less water without reducing yields such as the use of drip irrigation systems.

Agriculture also pollutes surface and groundwater by the excessive use of chemical fertilizers and pesticides. Methods such as the use of biomass as fertilizer and non toxic pesticides such as neem products and using integrated pest management systems might reduce the agricultural pollution of surface and ground water.

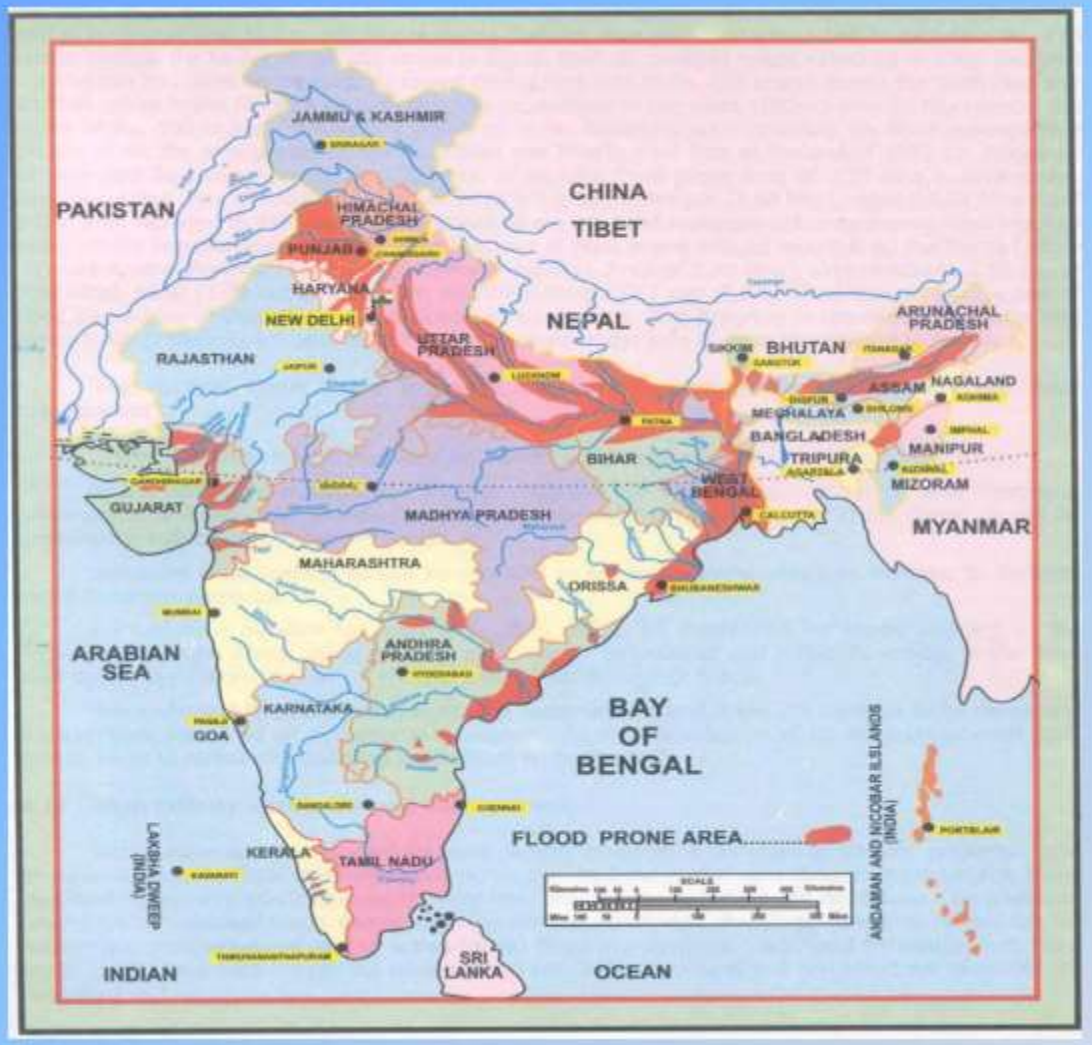
Industry tends to maximise short-term economic gains by not bothering about its liquid waste and releasing it into streams, rivers and the sea. Public awareness may increasingly put pressures on industry to produce only eco-friendly products which are already gaining in popularity

Global climate change: Changes in climate at a global level caused by increasing air pollution have now begun to affect our climate. In some regions **global warming** and the ***El Nino*** have created unprecedented storms. In other areas, they lead to long droughts. Everywhere the '**greenhouse effect**' due to atmospheric pollution is leading to increasingly unpredictable climatic effects. This has seriously affected regional hydrological conditions.

Water for Agriculture and Power Generation:

India's increasing demand for water for intensive irrigated agriculture, for generating electricity, and for consumption in urban and industrial centres, has been met by creating large dams. Irrigated areas increased from 40 million ha. in 1900 to 271 million ha. by 1998. Dams support 30 to 40% of this area.

Although dams ensure a year round supply of water for domestic use, provide extra water for agriculture, industry, hydropower generation, they have several serious environmental problems. They alter river flows, change nature's flood control mechanisms such as wetlands and flood plains, and destroy the lives of local people and the habitats of wild plant and animal species.



Flood Prone Area – 45.36 Mha

- About 22.7% of geographical area covered under DPAP

Acts

- Water (Prevention and Control of Pollution) Act 1974
- Environmental Protection Act 1986

Authorities

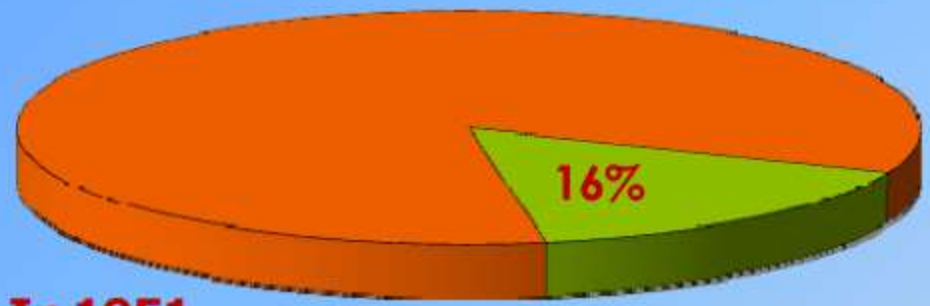
- Central Pollution Control Board
- Central Ground Water Authority
- Water Quality Assessment Authority

Major role of Union Ministry

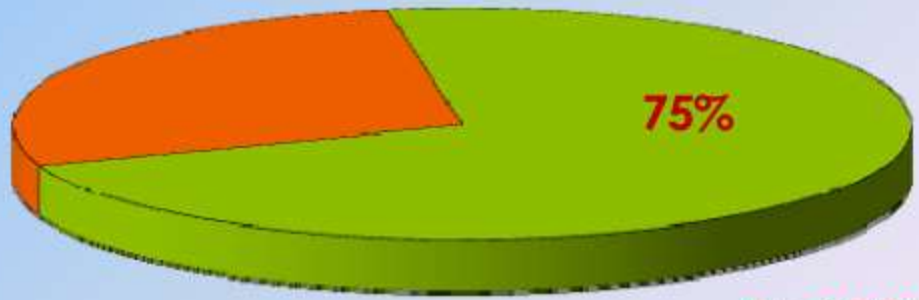
- Overall policy and planning
- Technical support
- Appraisal of project proposals
- Monitoring of important projects
- International co-operation

Potential Created as % of Ultimate Irrigation Potential

(about 140 Mha)



In 1951



In 2008

Per capita water availability

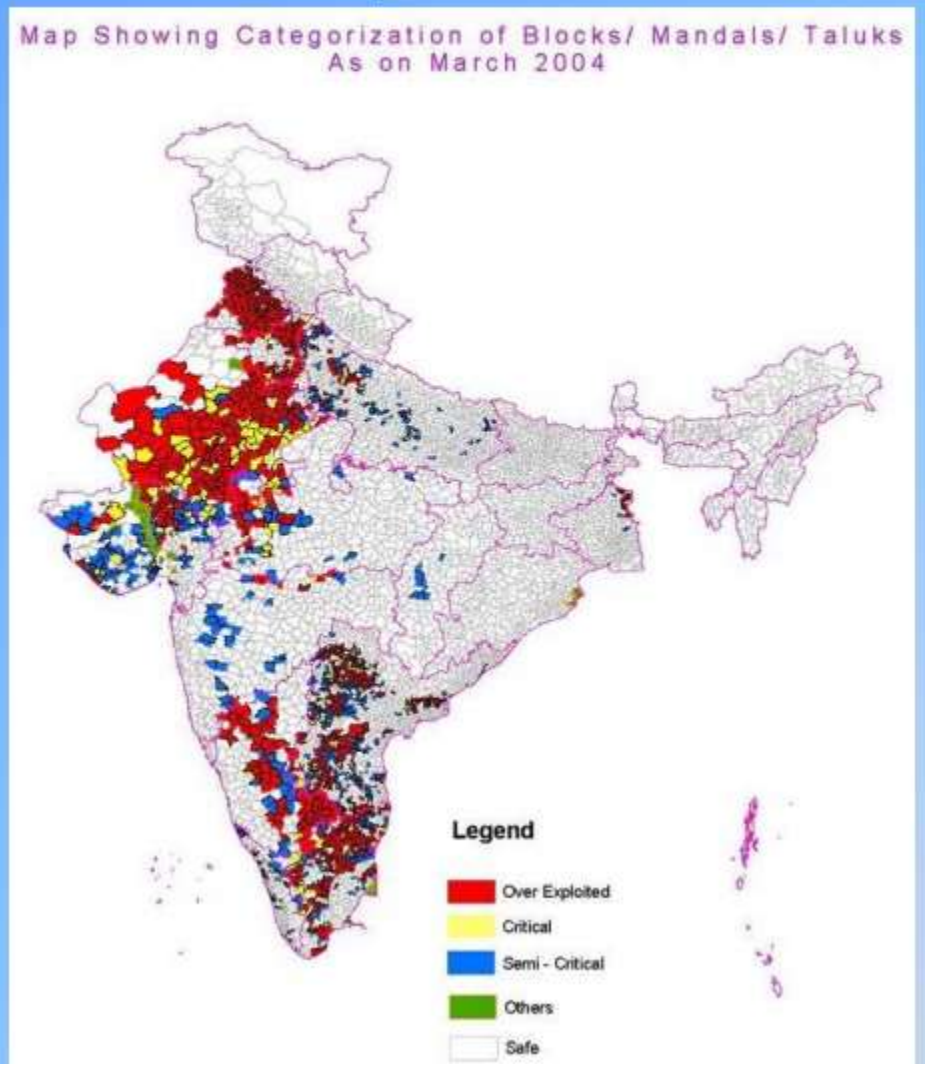
Overall water demand

(billion cubic metre)

In 2010	:	710
In 2025	:	843
In 2050	:	1180

Source : National Commission for Integrated Water Resource Development Plan

Ground water exploitation



- Total units 5723
- Safe 4078
- Semi critical 550
- Critical 226
- Overexploited 839

National Water Mission

Objective

"Conservation of water, minimizing wastage and ensuring its more equitable distribution both across and within States through integrated water resources management"

Goals

- Comprehensive water data base in public domain and assessment of the impact of climate change on water resources
- Promotion of citizen and State actions for water conservation, augmentation and preservation
- Focused attention to over-exploited areas
- Increasing water use efficiency at least by 20%
- Promotion of basin level integrated water resources management

Sustainable water management:

'Save water' campaigns are essential to make people everywhere aware of the dangers of water scarcity. A number of measures need to be taken for the better management of the world's water resources. These include measures such as:

- Building several small reservoirs instead of few mega projects.
- Develop small catchment dams and protect wetlands.
- Soil management, micro catchment development and afforestation permits recharging of underground aquifers thus reducing the need for large dams.
- Treating and recycling municipal waste water for agricultural use.
- Preventing leakages from dams and canals.
- Preventing loss in Municipal pipes.
- Effective rain water harvesting in urban environments.
- Water conservation measures in agriculture such as using drip irrigation.
- Pricing water at its real value makes people use it more responsibly and efficiently and reduces water wasting.
- In deforested areas where land has been degraded, soil management by bunding along the hill slopes and making 'nala' plugs, can help retain moisture and make it possible to re-vegetate degraded areas.

Managing a river system is best done by leaving its course as undisturbed as possible. Dams and canals lead to major floods in the monsoon and the drainage of wetlands seriously affects areas that get flooded when there is high rainfall.


What's wrong with this picture?

Energy resources

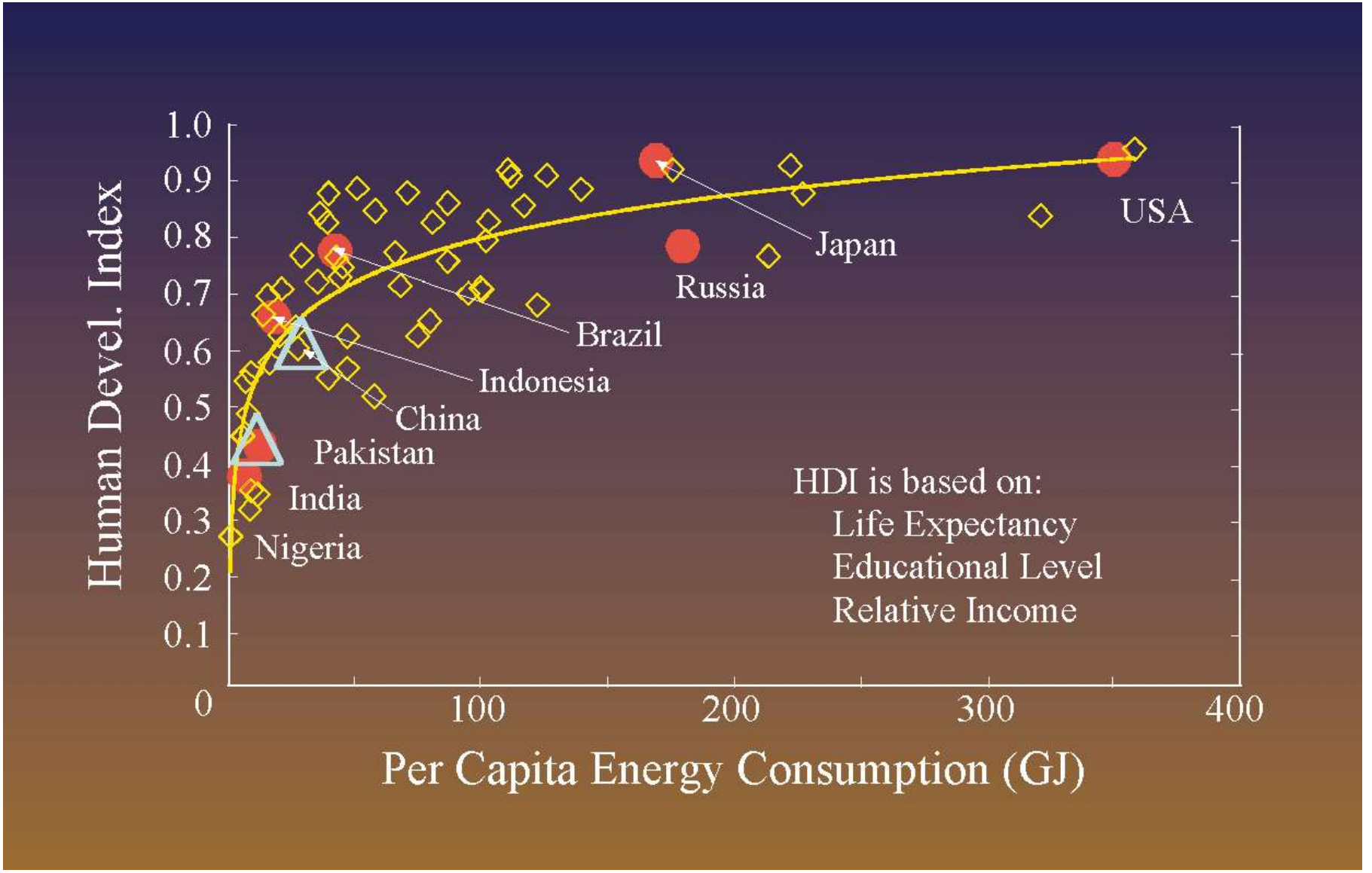
Energy is defined by physicists as the capacity to do work. Energy is found on our planet in a variety of forms, some of which are immediately useful to do work, while others require a process of transformation.

The sun is the primary energy source in our lives. We use it directly for its warmth and through various natural processes that provide us with food, water, fuel and shelter. The sun's rays power the growth of plants, which form our food material, give off oxygen which we breathe in and take up carbon dioxide that we breathe out. Energy from the sun evaporates water from oceans, rivers and lakes, to form clouds that turn into rain. Today's fossil fuels were once the forests that grew in prehistoric times due to the energy of the sun.

Chemical energy, contained in chemical compounds is released when they are broken down by animals in the presence of oxygen. Electrical energy produced in several ways, powers transport, artificial lighting, agriculture and industry.

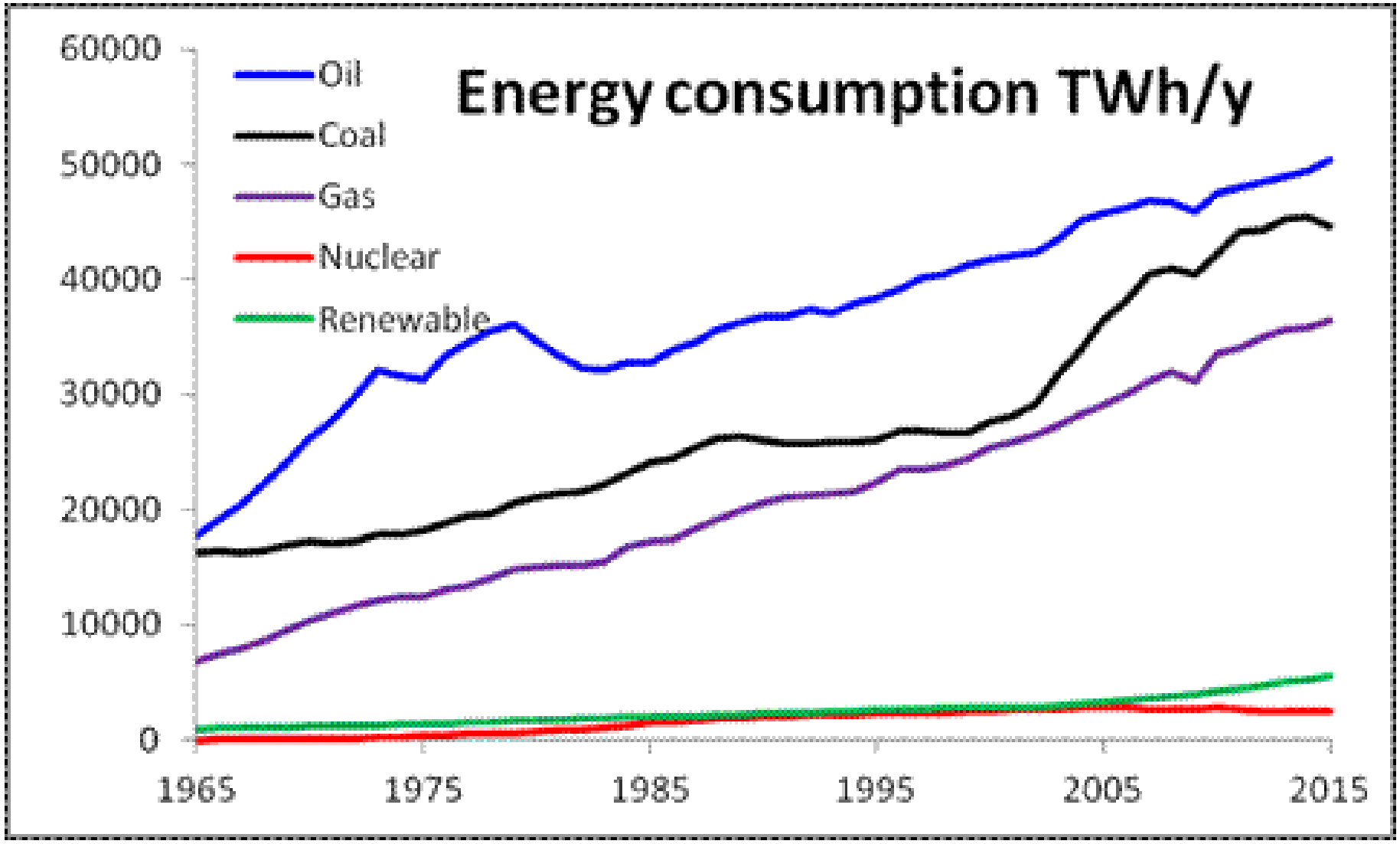
We use energy for household use, agriculture, production of industrial goods and for running transport. Modern agriculture uses chemical fertilizers, which require large amounts of energy during their manufacture. Industry uses energy to power manufacturing units and the urban complexes that support it. Energy-demanding roads and railway lines are built to transport products from place to place and to reach raw materials in mines and forests.

ENERGY AND THE MDGs - Clean energy is a key element for achieving all of the MDGs - poverty, hunger, education, gender equality, health, communicable diseases, and environmental sustainability.


Human Devel. Index
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
100
200
300
400
Per Capita Energy Consumption (GJ)
USA
Japan
Russia
Brazil
Indonesia
China
Pakistan
India
Nigeria
HDI is based on:
Life Expectancy
Educational Level
Relative Income

Growing energy needs: Energy has always been closely linked to human's economic growth and development. Present strategies for development that have focused on rapid economic growth have used energy utilization as an index of economic development. This index however, does not take into account the long-term ill effects on society of excessive energy utilisation.

Between 1950 and 1990, the world's energy needs increased four fold. The world's demand for electricity has doubled over the last 20 years! The world's total primary energy consumption in 2000 was 9096 million tons of oil. A global average per capita that works out to be 1.5 tons of oil. Electricity is at present the fastest growing form of end-use energy worldwide. By 2020 the Asia-Pacific region is expected to consume some 40% more energy than North America.


Energy consumption TWh/y
Oil
Coal
Gas
Nuclear
Renewable
60000
50000
40000
30000
20000
10000
0
1965
1975
1985
1995
2005
2015

Total world oil production in 2019 averaged 80,622,000 barrels per day. Approximately 68% came from the top ten countries, and an overlapping 44% came from the fourteen current OPEC members.

	Country	Oil Production (bbl/day)[1]	Oil Production per capita (bbl/day/million people)[5]
-	World Production	80,622,000	10,798
01	USA[6]	15,043,000	35,922
02	Saudi Arabia (OPEC)	12,000,000	324,866
03	Russia	10,800,000	73,292
04	Iraq (OPEC)	4,451,516	119,664
05	Iran (OPEC)	3,990,956	49,714
06	China	3,980,650	2,836
07	Canada	3,662,694	100,931
08	United Arab Emirates (OPEC)	3,106,077	335,103
09	Kuwait (OPEC)	2,923,825	721,575
10	Brazil	2,515,459	12,113
25	India	715,459	554

List of countries by oil consumption

Rank	Country/Region	Oil consumption (bbl/day)	Year
-	World	99,558,000	2018
1	United States	20,000,000	2018
-	European Union	15,000,000[4]	2017
2	China	13,500,000	2018
3	India	4,990,000	2018
4	Japan	3,988,000	2017
5	Saudi Arabia	3,918,000	2017
6	Russia	3,224,000	2017
7	Brazil	3,017,000	2017
8	South Korea	2,796,000	2017
9	Germany	2,447,000	2017
10	Canada	2,428,000	2017

How Large is a Quadrillion BTU?

It's about equal to the amount of energy in 45 million tons of coal, or 1 trillion cubic feet of natural gas, or 170 million barrels of coal.

For almost 200 years, coal was the primary energy source fuelling the industrial revolution in the 19th century. At the close of the 20th century, oil accounted for 39% of the world's commercial energy consumption, followed by coal (24%) and natural gas (24%), while nuclear (7%) and hydro/renewable (6%) accounted for the rest.

Among the commercial energy sources used in India, coal is a predominant source accounting for 55% of energy consumption estimated in 2001, followed by oil (31%), natural gas (8%), hydro (5%) and nuclear (1%). In India, biomass (mainly wood and dung) accounts for almost 40% of primary energy supply. While coal continues to remain the dominant fuel for electricity generation, nuclear power has been increasingly used since the 1970s and 1980s and the use of natural gas has increased rapidly in the 80s and 90s.

In 2000, China accounted for 28% of world coal consumption, other Asia consumed 19%, North America 25% and the EU 14%. The single greatest coal-consuming country is China. Its share of the world coal production was 28% in 2000 and rose to 48% in 2009. In contrast to China's ~70% increase in coal consumption, world coal use increased 48% from 2000 to 2009. China's energy consumption is mostly driven by the industry sector, the majority of which comes from coal consumption.

World annual coal production increased 1,905 Mt or 32% in 6 years in 2011 compared to 2005, of which over 70% was in China and 8% in India. Coal production was in 2011 7,783 Mt, and 2009 6,903 Mt, equal to 12.7% production increase in two years.

If production and consumption of coal continue at the rate as in 2008, proven and economically recoverable world reserves of coal would last for about 150 years. This is much more than needed for an irreversible climate catastrophe. Coal is the largest source of carbon dioxide emissions in the world. According to James Hansen the single most important action needed to tackle the climate crisis is to reduce CO_2 emissions from coal. Indonesia and Australia exported together 57.1% of the world coal export in 2011. China, Japan, South Korea, India and Taiwan had 65% share of all the world coal import in 2011.

Types of energy:

There are two main types of energy; those classified as **non-renewable**; those that are said to be **renewable**;

Non-Renewable Energy Sources: These consist of the mineral based hydrocarbon fuels coal, oil and natural gas, that were formed from ancient prehistoric forests. These are called '**fossil fuels**' because they are formed after plant life is fossilized.

At the present rate of extraction there is enough coal for a long time to come. Oil and gas resources however are likely to be used up within the next 50 years.

When these fuels are burnt, they produce waste products that are released into the atmosphere as gases such as carbon dioxide, oxides of sulphur, nitrogen, and carbon monoxide, all causes of air pollution.

Many of these gases also act like a green house letting sunlight in and trapping the heat inside. This is leading to global warming, a raise in global temperature, increased drought in some areas, floods in other regions, the melting of icecaps, and a rise in sea levels, which is slowly submerging coastal belts all over the world.

Oil powered vehicles emit carbon dioxide, sulphur dioxide, nitrous oxide, carbon monoxide and particulate matter which is a major cause of air pollution especially in cities with heavy traffic density. Leaded petrol, leads to neuro damage. Running petrol vehicles with unleaded fuel has been achieved by adding catalytic converters on all the new cars, but unleaded fuel contains benzene and butadene which are known to be cancerogenic compounds.

New Delhi, which used to have serious smog problems due to traffic, has been able to reduce this health hazard by changing a large number of its vehicles to CNG, which contains methane.

Coal and its environmental impacts: Coal is the world's single largest contributor of green house gases and is one of the most important causes of global warming. Many coal-based power generation plants are not fitted with devices such as electrostatic precipitators to reduce emissions of suspended particulate matter (SPM) which is a major contributor to air pollution. Burning coal also produces oxides of sulphur and nitrogen which, combined with water vapour, lead to 'acid rain'. This kills forest vegetation, and damages architectural heritage sites, pollutes water and affects human health.

Thermal power stations that use coal produce waste in the form of 'fly ash'. Large dumps are required to dispose off this waste material, while efforts have been made to use it for making bricks. The transport of large quantities of fly ash and its eventual dumping are costs that have to be included in calculating the cost-benefits of thermal power.

Renewable energy

Renewable energy systems use resources that are constantly replaced and are usually less polluting. Examples include hydropower, solar, wind, and geothermal (energy from the heat inside the earth). We also get renewable energy from burning trees and even garbage as fuel and processing other plants into biofuels.

Hydroelectric Power

This uses water flowing down a natural gradient to turn turbines to generate electricity known as 'hydroelectric power' by constructing dams across rivers. Between 1950 and 1970, Hydropower generation worldwide increased seven times. The long life of hydropower plants, the renewable nature of the energy source, very low operating and maintenance costs, and absence of inflationary pressures as in fossil fuels, are some of its advantages.

Drawbacks: Although hydroelectric power has led to economic progress around the world, it has created serious ecological problems.

- To produce hydroelectric power, large areas of forest and agricultural lands are submerged. These lands traditionally provided a livelihood for local tribal people and farmers. Conflicts over land use are inevitable.

- Silting of the reservoirs (especially as a result of deforestation) reduces the life of the hydroelectric power installations.

- Water is required for many other purposes besides power generation. These include domestic requirements, growing agricultural crops and for industry. This gives rise to conflicts.

With large dams causing social problems, there has been a trend to develop small hydroelectric generation units. Multiple small dams have less impact on the environment. China has the largest number of these - 60,000, generating 30% of China's electricity. Sweden, the US, Italy and France also have developed small dams for electrical power generation.

The development of small hydroelectric power units could become a very important resource in India.

Solar energy: In one hour, the sun pours as much energy onto the earth as we use in a whole year. If it were possible to harness this colossal quantum of energy, humanity would need no other source of energy. Today we have developed several methods of collecting this energy for heating water and generating electricity.

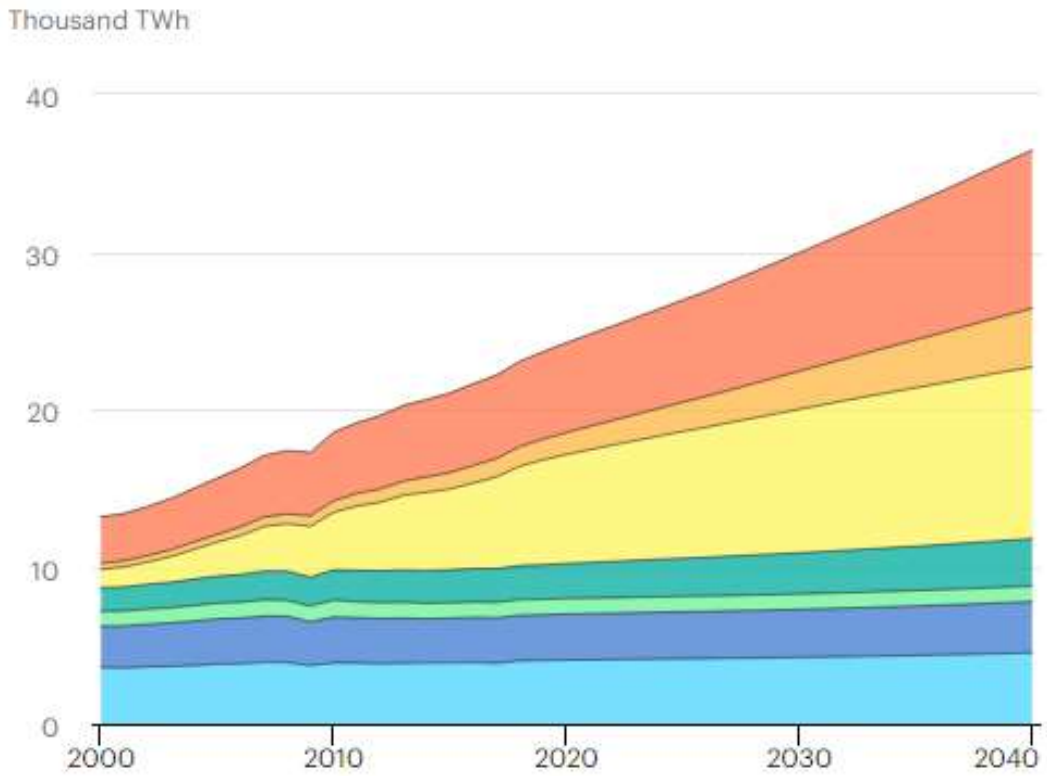
Solar thermal electric power: Solar radiation can produce high temperatures, which can generate electricity. Areas with low cloud levels of cover with little scattered radiation as in the desert are considered most suitable sites. According to a UNDP assessment, STE is about 20 years behind the wind energy market exploitation, but is expected to grow rapidly in the near future.

Biogas: Biogas is produced from plant material and animal waste, garbage, waste from households and some types of industrial wastes, such as fish processing, dairies, and sewage treatment plants. It is a mixture of gases which includes methane, carbon dioxide, hydrogen sulphide and water vapour. In this mixture, methane burns easily. With a ton of food waste, one can produce 85 Cu. M of biogas. Once used, the residue is used as an agricultural fertilizer.

Wind Power: Wind was the earliest energy source used for transportation by sailing ships. Some 2000 years ago, windmills were developed in China, Afghanistan and Persia to draw water for irrigation and grinding grain. Most of the early work on generating electricity from wind was carried out in Denmark, at the end of the last century.

Today, Denmark and USA have large wind turbine cooperatives which sell electricity to the government grid. In Tamil Nadu, there are large wind farms producing 850 megawatts of electricity. At present, India is the third largest wind energy producer in the world.

Global electricity demand by region in the Stated Policies Scenario, 2000-2040



United States · European Union · Japan · Other advanced economies · China · India · Other developing economies

Forest Resources:

Forests are formed by a community of plants which is predominantly structurally defined by its trees, shrubs, climbers and ground cover.

Natural vegetation looks vastly different from a group of planted trees, which are in orderly rows. The most 'natural' undisturbed forests are located mainly in our National Parks and Wildlife Sanctuaries. The landscapes that make up various types of forests look very different from each other. Each forest type forms a habitat for a specific community of animals that are adapted to live in it.

The forest ecosystem has two parts:

- **The non-living or abiotic aspects of the forest:**

The type of forest depends upon the abiotic conditions at the site. Forests on mountains / hills differ from those along river valleys. Vegetation is specific to the amount of rainfall and the local temperature which varies according to latitude and altitude.

- **The living or the biotic aspects of the forest:**

The plants and animals form communities that are specific to each forest type. For instance coniferous trees occur in the Himalayas. Mangrove trees occur in river deltas. Thorn trees grow in arid areas. The snow leopard lives in the Himalayas while the leopard and tiger live in the forests of the rest of India. Wild sheep and goats live high up in the Himalayas. Many of the birds of the Himalayan forests are different from the rest of India. Evergreen forests of the Western Ghats and North East India are most rich in plant and animal species.

Our lives and livelihoods depend directly on these resources. The water we use depends on the existence of forests on the watersheds around river valleys. Our homes, furniture and paper are made from wood from the forest.

We use many medicines that are based on forest produce. And we depend on the oxygen that plants give out and the removal of carbon dioxide we breathe out from the air.

FOREST FUNCTIONS

Watershed protection:
- Reduce the rate of surface run-off of water.
- Prevent flash floods and soil erosion.
- Produces prolonged gradual run-off and thus prevent effects of drought.

Atmospheric regulation:
- Absorption of solar heat during evapotranspiration.
- Maintaining carbon dioxide levels for plant growth.
- Maintaining the local climatic conditions.

Erosion control:
- Holding soil (by preventing rain from directly washing soil away).

Land bank:
- Maintenance of soil nutrients and structure.

Local use - Consumption of forest produce by local people who collect it for subsistence –(Consumptive use)
- Food - gathering plants, fishing, hunting from the forest.

- Fodder - for cattle.
- Fuel wood and charcoal for cooking, heating.
- Timber – household articles and construction.
- Fibre - weaving of baskets, ropes, nets, string, etc.
- Sericulture – for silk.
- Apiculture - bees for honey, forest bees also pollinate crops.
- Medicinal plants - traditionally used medicines, investigating them as potential source for new modern drugs.

Market use - (Productive use)

- Most of the above products used for consumptive purposes are also sold as a source of income for supporting the livelihoods of forest dwelling people.

- Minor forest produce - (non-wood products): Fuel wood, fruit, gum, fibre, etc. which are collected and sold in local markets as a source of income for forest dwellers.

- Major timber extraction - construction, industrial uses, paper pulp, etc. Timber extraction is done in India by the Forest Department, but illegal logging continues in many of the forests of India and the world.

Forest types in India: The forest type depends upon the abiotic factors such as climate and soil characteristics of a region. Forests in India can be broadly divided into **Coniferous forests** and **Broadleaved** forests.

They can also be classified according to the nature of their tree species – **evergreen, deciduous, xerophytic or thorn trees, mangroves,** etc.

They can also be classified according to the most abundant species of trees such as Sal or Teak forests. In many cases a forest is named after the abundant tree species.

Scientists estimate that India should ideally have 33 % of its land under forests. Today we have only about 12%. Thus, we need not only to protect existing forests but also to increase our forest cover.

Deforestation became a major concern in British times when a large amount of timber was extracted for building their ships. This led the British to develop scientific forestry in India. They however alienated local people by creating Reserved and Protected Forests which curtailed access to the resources. This led to a loss of stake in the conservation of the forests which led to a gradual degradation and fragmentation of forests across the length and breadth of the country.

Another period of over utilization and forest degradation occurred in the early period following independence as people felt that now that the British had gone they had a right to using our forests in any way we pleased.

One of India's serious environmental problems is forest degradation due to timber extraction and our dependence on fuel wood. A large number of poor rural people are still highly dependent on wood to cook their meals and heat their homes. We have not been able to plant enough trees to support the need for timber and fuel wood.

The National Forest Policy of 1988 now gives an added importance to JFM. Another resolution in 1990 provided a formal structure for community participation though the formation of Village Forest Committees. Based on these experiences, new JFM guidelines were issued in 2000. This stipulates that at least 25 per cent of the income from the area must go to the community.

From the initiation of the program, until 2002, there were 63,618 JFM Committees managing over 140,953 sq.km.

Joint Forest Management (JFM)

The need to include local communities in Forest Management has become a growing concern. Local people will only support greening an area if they can see some economic benefit from conservation. An informal arrangement between local communities and the Forest Department began in 1972, in Midnapore District of West Bengal.

JFM has now evolved into a formal agreement which identifies and respects the local community's rights and benefits that they need from forest resources. Under JFM schemes, Forest Protection Committees are formed from local community members. They participate in restoring green cover and protect the area from being over exploited.

Timber extraction, mining and dams are invariably parts of the needs of a developing country. If timber is overharvested the ecological functions of the forest are lost. Unfortunately, forests are located in areas where there are rich mineral resources. Forests also cover the steep embankments of river valleys, which are ideally suited to develop hydel and irrigation projects.

Thus, there is a constant conflict of interests between the conservation interests of environmental scientists and the Mining and Irrigation Departments. What needs to be understood is that long-term ecological gains cannot be sacrificed for short-term economic gains that unfortunately lead to deforestation. These forests where development projects are planned, can displace thousands of tribal people who lose their homes when these plans are executed. This leads to high levels of suffering for which there is rarely a satisfactory answer.