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Alternative Energy Resources in the 21st century – An Overview

1. Introduction

Energy is the primary and most universal measure of all kinds of work by human beings and nature. Energy is a crucial input in the process of economic, social and industrial development. As conventional energy sources are depleting day by day, utilization of alternative energy sources is the only solution. The increased power demand, depleting fossil fuel resources and growing environmental pollution have led the world to think seriously for other alternative sources of energy. Basic concepts of alternative energy resources are related to the issues of sustainability, renewability and pollution reduction. Here we have discussed about various alternative energy resources and their usability for future demands.

2. Present Scenario

Development of any country is directly related to the energy resources present since energy is the backbone of technology. To meet the necessary demands great pressures have been created on the natural energy resources. Thus it is essential for today's world to concentrate on renewable ones to satisfy the demand and conserve our finite natural resources for the generations to come. Since the major energy comes from the finite, non renewable fossil fuels thus it becomes crucial to look for other renewable alternate energy sources such as Solar, Wind, and Biomass etc. The bulk of demand for oil is from transport sector and in order to reduce the pressure from this sector it is necessary to explore possibilities of developing substitute fuels like bio-mass etc.

3. Types of Energy Resources

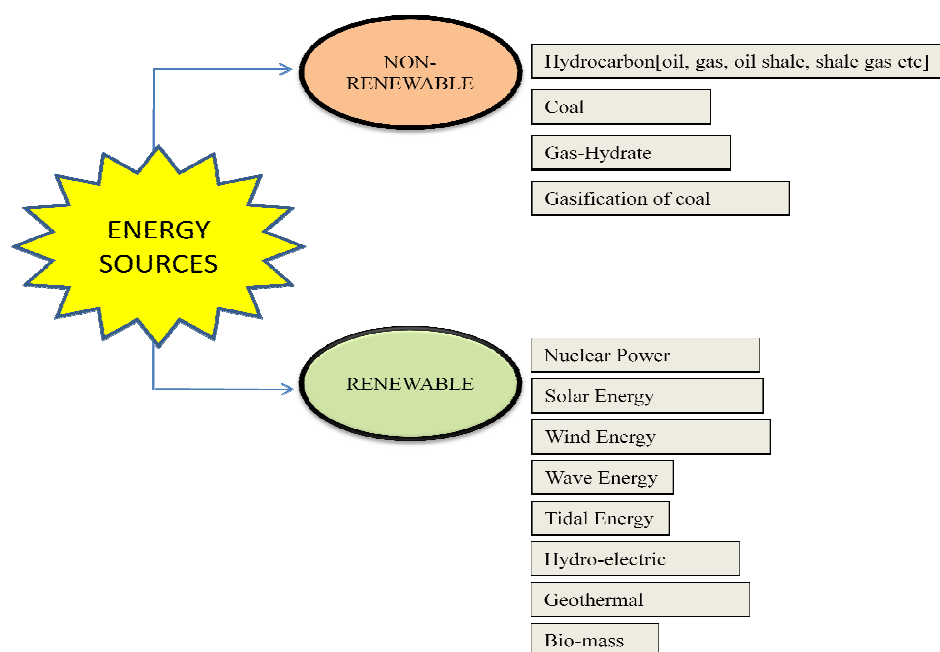


Figure 1: Energy source classification depending on the renewability

4. Salient Features, Advantages & Disadvantages

4.1. Non-renewable

4.1.1 Hydrocarbon [oil, gas, oil shale, shale gas etc]

Hydrocarbon, i.e., oil and gas are called "fossil fuels" because they have been formed from the organic remains of plants and animals. Coal is crushed to a fine dust and burnt. Oil and gas can be burnt directly. Other fossil fuels are being investigated, such as bituminous sands and oil shale. The difficulty is that they need expensive processing before we can use them,

<u>Advantages:</u>	<u>Disadvantages:</u>
<ol style="list-style-type: none"> 1. Transporting oil and gas to the power stations is easy. 2. Gas-fired power stations are very efficient. 	<ol style="list-style-type: none"> 1. Environment Pollution. Produces greenhouse gases e.g., CO₂, CO etc. 2. Very limited reserve and explorations and exploitations are costly, especially from offshore.

4.1.2 Coal:

Coal, another "fossil fuels" formed from the organic remains of plants. Coal is crushed to a fine dust and burnt to produce energy. Thermal plants, steel plants, domestic use, are some of the many applications of coal as energy resource.

<u>Advantages:</u>	<u>Disadvantages:</u>
<ol style="list-style-type: none"> 1. Large amounts of electricity can be generated in one place using coal, fairly cheaply. 2. A coal power station can be built almost anywhere, as long as large quantities of coal are available. 	<ol style="list-style-type: none"> 1. Burning coal produces greenhouse gases like CO₂, CO and SO₂ [causes acid rain], etc. 2. Mining coal can be dangerous as it causes fire, caving-in and other human hazards. 3. Strip mining destroys large areas of the landscape.

4.1.3 Gasification of coal:

Coal gasification is the process of producing coal gas, a type of syngas –a mixture of carbon monoxide (CO) and hydrogen (H₂) gas—from coal. Carbon monoxide, which is a combustible gas, was traditionally used as a source of energy for municipal lighting and heat before the advent of industrial-scale production of natural gas, while the hydrogen obtained from gasification can be used for other purposes.

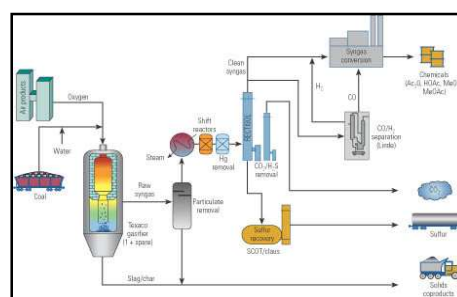
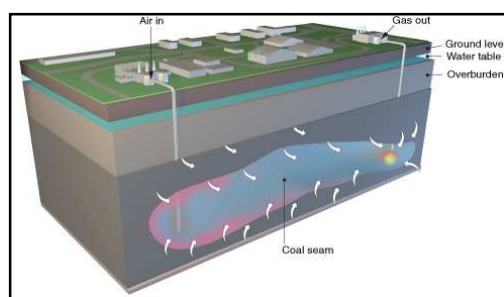


Figure 2: Energy source classification depending on the renewability

Other fossil fuels are being investigated, such as bituminous sands and oil shale. The difficulty is that they need expensive processing before we can use them.

4.1.4 Gas-Hydrate:

Gas-hydrates are crystalline solid consisting of gas molecules usually methane, each surrounded by a cage of water molecules. One volume hydrate is equivalent to 160 volumes of methane gas. Vast continental margins with substantial sediment thickness and organic content provide favourable conditions for occurrence of gas hydrates in the deep waters adjoining the Indian continent.

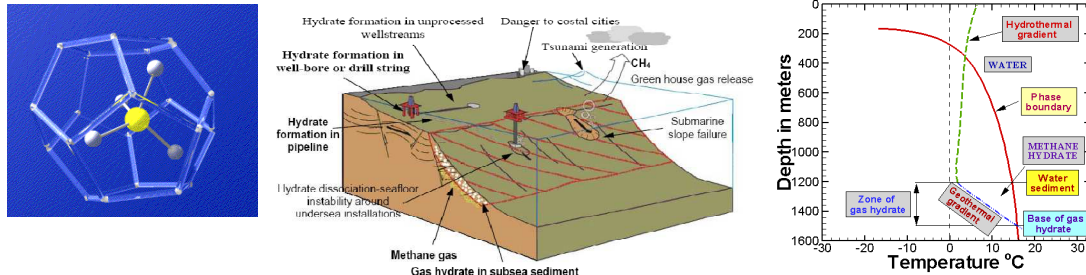


Figure 3: Molecular Structure, Generation & Stability Zone, P-T condition.

<u>Advantages:</u>	<u>Disadvantages:</u>
<ol style="list-style-type: none"> 1. Huge potential and recovery, once commerciality is proven 	<ol style="list-style-type: none"> 1. Gas hydrates hold the danger of natural hazards associated with sea floor stability, release of methane to ocean and atmosphere, 2. It disturbs during drilling and pose a safety problem

4.1.5 Nuclear Power:

Nuclear power is generated using Uranium, which is a metal mined in various parts of the world. Nuclear power stations work in pretty much the same way as fossil fuel-burning stations, except that a "chain reaction" inside a nuclear reactor makes the heat instead.

<u>Advantages:</u>	<u>Disadvantages:</u>
<ol style="list-style-type: none"> 1. Nuclear power costs about the same as coal, so it's not expensive to make. 2. Does not contribute to the greenhouse effect. 3. Produces huge amounts of energy from small amounts of fuel. 4. Produces small amount of wastes. 	<ol style="list-style-type: none"> 1. Unless disposed properly nuclear waste is very dangerous. 2. Nuclear power is reliable, but a lot of money has to be spent on safety - if it does go wrong, a nuclear accident can be a major disaster. 3. Nuclear reactors lasts only for about 40 to 50 years

4.2 Renewable

4.2.1 Solar Power:

Solar energy is the energy force that sustains life on the earth for all plants, animals, and people. This energy can be tapped directly as solar energy (thermal and photovoltaic), and indirectly as wind, biomass, waterpower, wave energy, and ocean temperature difference. Solar energy can be used to meet our energy requirements, like Electricity. This stored energy can be used even at night. E.g. domestic/street lighting, desalination of salty water, water pumping, railway signalling, powering of remote telecommunication repeater stations, village electrification, etc.

<u>Advantages:</u>	<u>Disadvantages:</u>
<ol style="list-style-type: none"> 1. Renewable/ Inexhaustible 2. Pollution free 	<ol style="list-style-type: none"> 1. High initial cost 2. Depends on the geographic location and time

4.2.2 Wind Power:

Wind results from air in motion due to pressure gradient that is caused by the solar energy irradiating the earth. Wind possesses energy by virtue of its motion. Any device capable of slowing down the mass of moving air can extract part of the energy and convert into useful work.

<u>Advantages:</u>	<u>Disadvantages:</u>
<ol style="list-style-type: none"> 1. Wind is free, wind farms need no fuel. 2. No waste or greenhouse gases. 3. The land beneath can usually still be used for farming. 4. Wind farms can be tourist attractions. 5. A good method of supplying energy to remote areas. 	<ol style="list-style-type: none"> 1. Selection of site depends upon various factors [annual average wind speed, terrain aerodynamics, ecology, land availability & cost etc] 2. Wind energy is fluctuating in nature 3. High initial cost & maintenance 4. Noisy. Wind generators have a reputation for making a constant, low, "swooshing" noise day and night 5. Can kill migratory birds.

4.2.3 Wave Power:

Sea waves can be used as a renewable source of energy. The main two factors affecting the magnitude of wave energy are wind strength & uninterrupted distance over the sea that the wind can blow. Wave energy is promising and holds huge potential to reduce reliance on fossil fuels. Carefully choosing sites that can withstand the alterations to the environment caused by power plants will be crucial to effectively develop these technologies without harming the ocean.

<u>Advantages:</u>	<u>Disadvantages:</u>
<ol style="list-style-type: none"> 1. The energy is free - no fuel needed, no waste produced. 2. Not expensive to operate and maintain. 3. Can produce a great deal of energy. 	<ol style="list-style-type: none"> 1. Fluctuating in nature. 2. Needs a suitable site, where waves are consistently strong. 3. Some designs are noisy. But then again, so are waves, so any noise is unlikely to be a problem. 4. Must be able to withstand very rough weather. 5. Might harm the marine ecosystem

4.2.4 Tidal Power

The tide moves a huge amount of water twice each day, and harnessing it could provide a great deal of energy. A huge dam (called a "barrage") is built across a river estuary. When the tide goes in and out, the water flows through tunnels in the dam.

<u>Advantages:</u>	<u>Disadvantages:</u>
<ol style="list-style-type: none"> 1. Renewable 2. Pollution free 3. No fuel requirement 4. Tides are totally predictable 	<ol style="list-style-type: none"> 1. A barrage across an estuary is very expensive to build, and affects a very wide area - the environment is changed for many miles upstream and downstream. 2. Tide is active only 10 hours daily 3. There are few suitable sites for tidal barrages

4.2.5 Hydro-electric Power:

A dam is built to trap water, usually in a valley where there is an existing lake. Water is allowed to flow through tunnels in the dam, to turn turbines and thus drive electric power generators.

<u>Advantages:</u>	<u>Disadvantages:</u>
<ol style="list-style-type: none"> 1. Once the dam is built, the energy is virtually free. 2. No waste or pollution produced. 3. Much more reliable than wind, solar or wave power. 4. Electricity can be generated constantly. 	<ol style="list-style-type: none"> 1. Initial construction and installation cost is high. 2. Building a large dam can cause flood in upstream, causing problems for animals that used to live there. 3. Finding a suitable site can be difficult - the impact on residents and the environment may be unacceptable. 4. Water quality and quantity downstream can be affected, which can have an impact on plant life. 5. It can sometimes change the natural flow of the water which can harm plants and animals in the water.

4.2.6 Geothermal Power:

Geothermal power is generated by injecting water into a borehole and circulating through a "heat exchanger" of hot cracked volcanic rock several kilometres below the surface. The water is heated through contact with the rock and is then returned to the surface through another borehole where it is used to generate electricity. The water is then re-injected into the first borehole to be reheated and used again.

<u>Advantages:</u>	<u>Disadvantages:</u>
<ol style="list-style-type: none"> 1. Does not contribute to the greenhouse effect. 2. The power stations do not take up much room. 3. No fuel is needed. 4. Once a geothermal power station is built, the energy is almost free. 5. Hot water near the surface of Earth can be used directly for heating buildings, growing plants in greenhouses and many other domestic uses. 	<ol style="list-style-type: none"> 1. Limited to volcanically active places[e.g. New Zealand, Iceland] 2. Geothermal water is often saline, i.e. can only be used through a heat exchanger. The two liquids never come into contact resulting in a loss of efficiency. 3. Geothermal water is almost always corrosive. This corrosion (due to salt, but sometimes also bacteria) increases maintenance costs. 4. Hazardous gases and minerals may come up from underground, and can be difficult to dispose of. 5. Currently, there are no commercial applications of this technology.

4.2.7 Bio-mass:

Use of renewable biomass (including energy crops and organic wastes) as an energy resource is not only greener with respect to most pollutants, but its use represents a closed balanced carbon cycle with respect to atmospheric carbon dioxide. It could also mitigate atmospheric carbon dioxide levels through replacement of fossil fuels. Biomass may be converted to a variety of energy forms including heat, steam, electricity, hydrogen, ethanol, methanol and methane.

<u>Advantages:</u>	<u>Disadvantages:</u>
<ol style="list-style-type: none"> 1. Renewable [planting trees, feeding animals] 2. Cheap and easily available energy 3. Provides hygienic, clean and 	<ol style="list-style-type: none"> 1. Limited to rural areas with huge number of animal wastes etc 2. Nearby water supply (to dilute the dung) 3. Collecting or growing the fuel in sufficient quantities can be difficult.

safe atmosphere around populated areas	4. We burn the bio-fuel, so it makes greenhouse gases just like fossil fuels do.
4. Its slurry could be used as a nutrient rich manure in farms	5. Some waste materials are not available all year round

5. Conclusion

All energy resources have an impact on the environment. Concerns about the greenhouse effect, air pollution, and energy security have led to increasing interest and more development in renewable energy sources such as solar, wind, geothermal, wave power etc. It is best to use combinations of alternative energy resources as per the availability & geographic position of the area. Also, it is worth thinking about sharing energy globally – as the supply and demand may not always be balanced locally but can be met globally, as we need to continue to use fossil fuels and nuclear energy until new, cleaner and renewable energy sources and generation technologies can replace them.

Using every yardstick, i.e., availability, efficiency, environment, and cost, the 21st century will see an irrevocable shift towards environment friendly energy generation. The future is ours, but we need energy to get there.

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