Innovations in renewable energy sources

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ABSTRACT

The electricity requirements of the world including India are increasing at alarming rate and the power demand has been running ahead of supply. It is also now widely recognized that the fossil fuels (i.e., coal, petroleum and natural gas) and other conventional resources, presently being used for generation of electrical energy, may not be either sufficient or suitable to keep pace with ever increasing demand of the electrical energy of the world. Also generation of electrical power by cold based steam power plant or nuclear power plants causes pollution, which is likely to be more acute in future due to large generating capacity on one side and greater awareness of the people in this respect.

The recent severe energy crisis has forced the world to develop new and alternative methods of power generation, which could not be adopted so far due to various reasons. The magneto-hydro-dynamic (MHD) power generation is one of the examples of a new unique method of power generation. The other non-conventional methods of power generation may be such as solar power generation, wind power generation, biomass energy, geo-thermal energy generation, tidal power generation etc. In this, we are going to know the importance and innovations of various renewable energy sources and their growth.

Keywords: Renewable energy, innovation

INTRODUCTION

Renewable energy is derived from natural processes that are replenished constantly. In its various forms, it derives directly from the sun, or from heat generated deep within the

earth. Included in the definition is electricity and heat generated from solar, wind, ocean, hydropower, biomass, geothermal resources, and biofuels and hydrogen derived from renewable resources. It would also reduce environmental pollution such as air pollution caused by burning of fossil fuels and improve public health, reduce premature mortalities due to pollution and save associated health costs that amount to several hundred billion dollars annually only in the United States. Renewable energy often displaces conventional fuels in four areas: electricity generation, hot water/space heating, transportation, and rural (off-grid) energy services

In renewable energy sources, main stream technologies are:

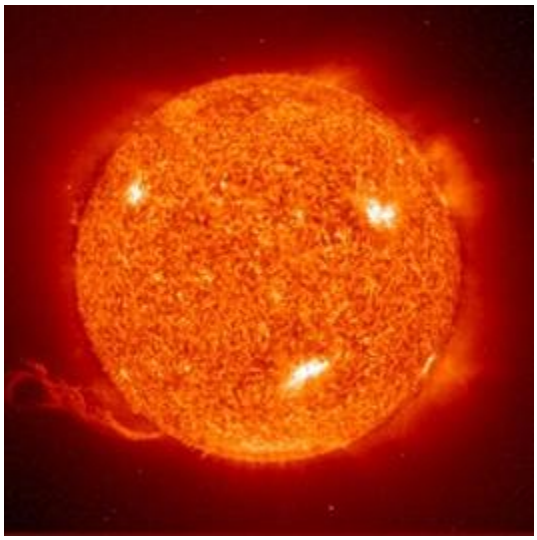
1. Solar energy
2. Wind energy
3. Hydropower energy
4. Biomass energy
5. Geothermal energy

1. SOLAR ENERGY

A. Energy from the sun

The sun has produced energy for billions of years and is the ultimate source for all of the energy sources and fuels that we use today. People have used the sun's rays (solar radiation) for thousands of years for warmth and to dry meat, fruit, and grains. Over time, people developed devices (technologies) to collect solar energy for heat and to convert it into electricity.

Radiant energy from the sun has powered life on earth for many millions of years.



Source: NASA

B. Collecting and using solar thermal (heat) energy

An example of an early solar energy collection device is the solar oven (a box for collecting and absorbing sunlight). In the 1830s, British astronomer John Herschel used a solar oven to cook food during an expedition to Africa. People now use many different technologies for collecting and converting solar radiation into useful heat energy for a variety of purposes.

C. Solar photovoltaic systems convert sunlight into electricity

Solar photovoltaic (PV) devices, or solar cells, change sunlight directly into electricity. Small PV cells can power calculators, watches, and other small electronic devices. Arrangements of many solar cells in PV panels and arrangements of multiple PV panels in PV arrays can produce electricity for an entire house. Some PV power plants have large arrays that cover many acres to produce electricity for thousands of homes.

D. Solar energy has benefits and some limitations

The two main benefits of using solar energy:

- Solar energy systems do not produce air pollutants or carbon dioxide.
- Solar energy systems on buildings have minimal effects on the environment.

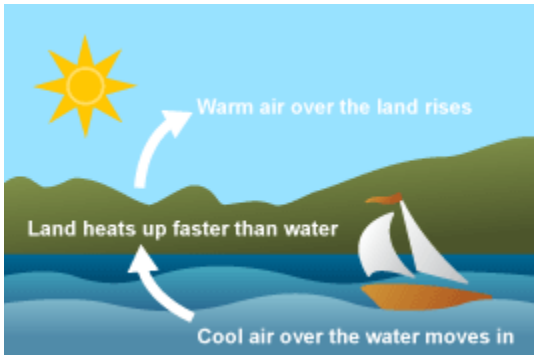
The main limitations of solar energy:

- The amount of sunlight that arrives at the earth's surface is not constant. The amount of sunlight varies depending on location, time of day, season of the year, and weather conditions.
- The amount of sunlight reaching a square foot of the earth's surface is relatively small, so a large surface area is necessary to absorb or collect a useful amount of energy.

2. WIND ENERGY

A. Energy from moving air

How uneven heating of water and land causes wind



Source: Adapted from National Energy Education Development Project (public domain)

Wind is caused by uneven heating of the earth's surface by the sun. Because the earth's surface is made up of different types of land and water, it absorbs the sun's heat at different rates. One example of this uneven heating is the daily wind cycle.

The daily wind cycle

During the day, air above the land heats up faster than air over water. Warm air over land expands and rises, and heavier, cooler air rushes in to take its place, creating wind. At night, the winds are reversed because air

cools more rapidly over land than it does over water.

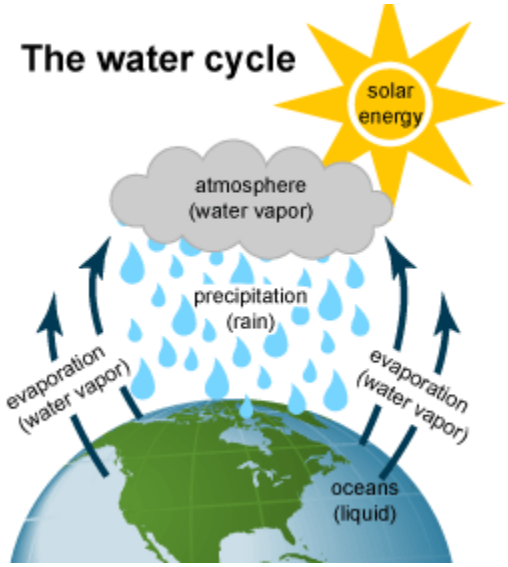
In the same way, the atmospheric winds that circle the earth are created because the land near the earth's equator is hotter than the land near the North Pole and the South Pole.

B. Wind energy for electricity generation

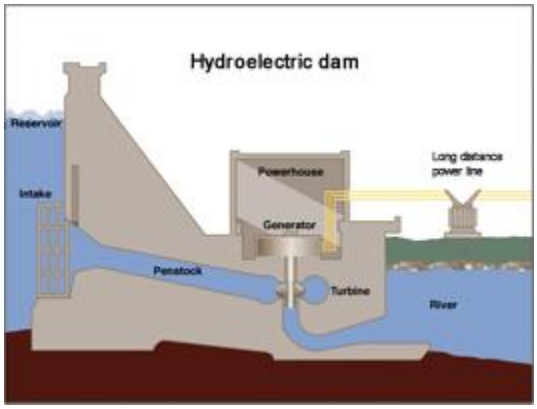
Today, wind energy is mainly used to generate electricity. Water pumping windmills were once used throughout the United States and some still operate on farms and ranches, mainly to supply water for livestock

3. HYDROPOWER ENERGY

A. Energy from moving water



Source: Adapted from National Energy Education Development Project (public domain)



Source: Tennessee Valley Authority (public domain)

Hydropower generates electricity

Hydropower is the largest renewable energy source for electricity generation in the United States. In 2016, hydropower accounted for about 6.5% of total U.S. utility-scale electricity generation and 44% of total utility-scale electricity generation from all renewable energy.

Because the source of hydroelectric power is water, hydroelectric power plants are usually located on or near a water source.

B. Hydropower relies on the water cycle

Understanding the water cycle is important to understanding hydropower. The water cycle has three steps:

- Solar energy heats water on the surface of rivers, lakes, and oceans, which causes the water to evaporate.
- Water vapor condenses into clouds and falls as precipitation (rain, snow, etc.).
- Precipitation collects in streams and rivers, which empty into oceans and lakes, where it evaporates and begins the cycle again.

The amount of precipitation that drains into rivers and streams in a geographic area determines the amount of water available for producing hydropower. Seasonal variations in precipitation and long-term changes in precipitation patterns, such as droughts, have a big impact on hydropower production.

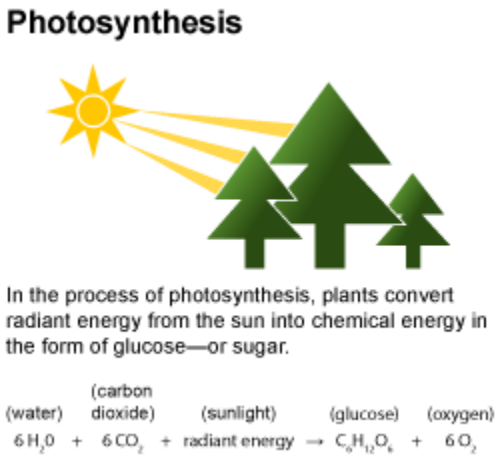
C. Hydroelectric power is produced from moving water

The volume of the water flow and the change in elevation (or fall) from one point to another determine the amount of available energy in moving water. Swiftly flowing water in a big river, like the Columbia River that forms the border between Oregon and Washington, carries a great deal of energy in its flow. Water descending rapidly from a high point, like Niagara Falls in New York, also has substantial energy in its flow.

At both Niagara Falls and the Columbia River, water flows through a pipe, or *penstock*, then pushes against and turns blades in a turbine to spin a generator to produce electricity. In a *run-of-the-river system*, the force of the current applies pressure on a turbine. In a *storage system*, water accumulates in reservoirs created by dams and is released as needed to generate electricity.

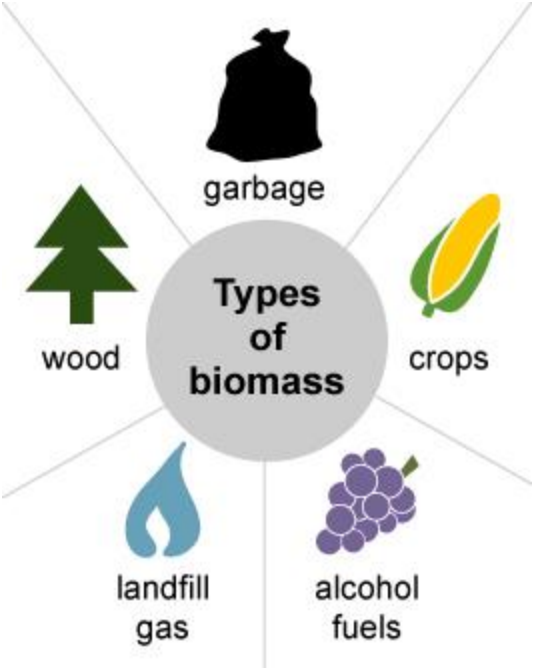
4. BIOMASS ENERGY

A. Biomass—renewable energy from plants and animals



In the process of photosynthesis, plants convert radiant energy from the sun into chemical energy in the form of glucose—or sugar.

Source: Adapted from The National Energy Education Project (public domain)



Source: Adapted from The National Energy Education Project (public domain)

Biomass is organic material that comes from plants and animals, and it is a renewable source of energy.

Biomass contains stored energy from the sun. Plants absorb the sun's energy in a process called photosynthesis. When biomass is burned, the chemical energy in biomass is released as heat. Biomass can be burned directly or converted to liquid biofuels or biogas that can be burned as fuels. Examples of biomass and their uses for energy:

- wood and wood processing wastes—burned to heat buildings, to produce process heat in industry, and to generate electricity
- agricultural crops and waste materials—burned as a fuel or converted to liquid biofuels
- food, yard, and wood waste in garbage—burned to generate electricity in power plants or converted to biogas in landfills
- animal manure and human sewage—converted to biogas, which can be burned as a fuel

B. Converting biomass to other forms of energy

Burning is only one way to release the energy in biomass. Biomass can be converted to other useable forms of energy such as methane gas or transportation fuels such as ethanol and biodiesel.

Methane gas is a component of *landfill gas* or *biogas* that forms when garbage, agricultural waste, and human waste decompose in landfills or in special containers called digesters.

Crops such as corn and sugar cane are fermented to produce fuel ethanol for use in vehicles. Biodiesel, another transportation fuel, is produced from vegetable oils and animal fats.

C. Biomass—Wood and wood waste

People have used wood for cooking, for heat, and for light for thousands of years. Wood was the main source of energy for the world until the mid-1800s. Wood continues to be an important fuel in many countries, especially for cooking and heating in developing countries.

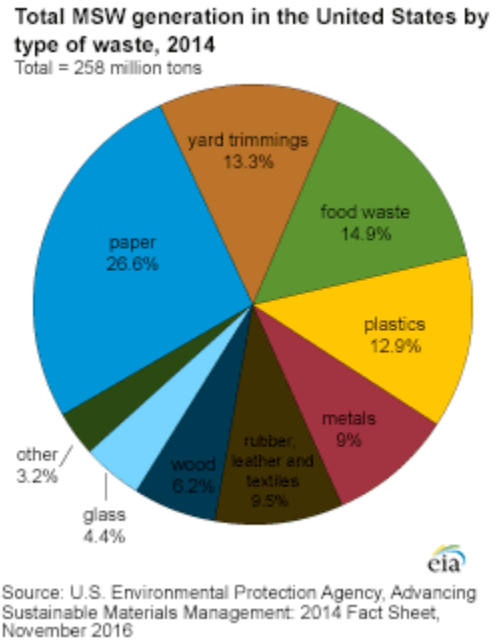
Using wood and wood waste

Industry, electric power producers, and commercial businesses use most of the wood and wood waste fuel consumed in the United States. The wood and paper products industry uses wood waste to produce steam and electricity, which saves money because it reduces the amount of other fuels and electricity that must be purchased. Some coal-burning power plants burn wood chips to reduce sulfur dioxide emissions.

About 19% of total U.S. wood energy consumption in 2016 was by the residential sector, and wood energy accounted for about 2% of total residential energy consumption.

D. Energy from municipal solid waste

Municipal solid waste (MSW), often called garbage, is used to produce energy at waste-to-energy plants and at landfills in the United States. MSW contains



Source: U.S. Environmental Protection Agency, Advancing Sustainable Materials Management: 2014 Fact Sheet, November 2016

- biomass, or biogenic (plant or animal products), materials such as paper, cardboard, food waste, grass clippings, leaves, wood, leather products
- non biomass combustible materials such as plastics and other synthetic materials made from petroleum
- noncombustible materials such as glass and metals

E. Waste-to-energy plants make steam and electricity

MSW is usually burned at special waste-to-energy plants that use the heat from the fire to make steam for generating electricity or to heat buildings. In 2015, 71 waste-to-

energy power plants and four other power plants burned MSW in the United States. These plants burned about 29 million tons of MSW in 2015 and generated nearly 14 billion kilowatthours of electricity. The biomass materials in the MSW that were burned in these power plants accounted for about 64% of the weight of the MSW and contributed about 51% of the energy. The remainder of the MSW was nonbiomass combustible material, mainly plastics. Many large landfills also generate electricity by using the methane gas that is produced from decomposing biomass in landfills.

F. Ethanol is made from biomass

Ethanol is a renewable biofuel because it is made from biomass. Ethanol is a clear, colorless alcohol made from a variety of biomass materials called feedstocks (the raw materials used to make a product). Fuel ethanol feedstocks include grains and crops with high starch and sugar content such as corn, sorghum, barley, sugar cane, and sugar beets. Ethanol can also be made from grasses, trees, and agricultural and forestry residues such as corn cobs and stocks, rice straw, sawdust, and wood chips. Ethanol is made from these feedstocks in several ways.

USDA researchers adding yeast to begin ethanol fermentation

Photo Credit: Scott Bauer, USDA Agricultural Research Service(public domain)

G. Fermentation is the most common method for fuel ethanol production

The most common ethanol production processes today use yeast to ferment the starch and sugars in corn, sugar cane, and sugar beets. Corn is the main feedstock for fuel ethanol in the United States because of its abundance and low price. The starch in corn kernels is fermented into sugar, which is then fermented into alcohol.

Sugar cane and sugar beets are the most common feedstocks used to make fuel ethanol in other parts of the world. Because alcohol is made by fermenting sugar, sugar crops are the easiest ingredients to convert into alcohol. Brazil, the world's second-largest fuel ethanol producer after the United States, makes most of its fuel ethanol from sugar cane. Most of the cars in Brazil can run on pure ethanol or on a blend of gasoline and ethanol.

H. Cellulosic ethanol is a large potential source of fuel ethanol

Ethanol can also be produced by breaking down cellulose in plant fibers.

This *cellulosic ethanol* is considered an advanced biofuel and involves a more complicated production process than fermentation. While large potential sources of cellulosic feedstocks exist, commercial production of cellulosic fuel ethanol is relatively small.

History of ethanol

Model T car

Source: Stock photography (copyrighted)

In the 1850s, ethanol was a major lighting fuel. During the Civil War, a liquor tax was placed on ethanol to raise money for the war. The tax increased the price of ethanol so much that it could no longer compete with other fuels such as kerosene. Ethanol production declined sharply because of this tax, and production levels did not begin to recover until the tax was repealed in 1906.

The Model T ran on ethanol

In 1908, Henry Ford designed his Model T, a very early automobile, to run on a mixture of gasoline and alcohol. Ford called this mixture the fuel of the future. In 1919, when Prohibition began, ethanol was banned because it was considered an alcoholic beverage. It could only be sold when mixed with petroleum. Ethanol was used as a fuel again after Prohibition ended in 1933.

I. Ethanol is once again used to fuel automobiles

Ethanol use increased temporarily during World War II when oil and other resources were scarce. In the 1970s, interest in ethanol as a transportation fuel was revived as oil embargoes, rising oil prices, and growing dependence on imported oil increased interest in alternative fuels. Since that time, ethanol use and production has been encouraged by tax benefits and by environmental regulations that require cleaner-burning fuels.

J. Biodiesel is made from vegetable oils and animal fats

Biodiesel is a renewable fuel that can be used instead of the diesel fuel made from petroleum. Biodiesel can be made from vegetable oils and animal fats.

In 2016, soybean oil was the source of about 55% of the total feedstock (raw material) used to produce biodiesel in the United States. Canola oil and corn oil were the source of about 22%, recycled grease about 13%, and animal fats about 10% of the total feedstock. Rapeseed oil, sunflower oil, and palm oil are other major sources of the biodiesel that is consumed in other countries.

Biodiesel is most often blended with petroleum diesel in ratios of 2% (B2), 5% (B5), or 20% (B20). Biodiesel can also be used as pure biodiesel (B100). Biodiesel fuels can be used in regular diesel engines without making any changes to the engines. Biodiesel can also be stored and transported using diesel fuel tanks and equipment.

History of biodiesel

Before petroleum diesel fuel became popular, Rudolf Diesel, the inventor of the diesel engine in 1897, experimented with using vegetable oil (biodiesel) as fuel.

5. GEOTHERMAL ENERGY

A. What is geothermal energy?

The word geothermal comes from the Greek words geo (earth) and therme (heat). Geothermal energy is heat within the earth. People can use this heat as steam or as hot water to heat buildings or to generate electricity.

Geothermal energy is a renewable energy source because heat is continuously produced inside the earth.

Geothermal energy comes from deep inside the earth

Source: Adapted from a National Energy Education Development Project graphic (public domain)

The slow decay of radioactive particles in the earth's core, a process that happens in all rocks, produces geothermal energy. The earth's core is hotter than the sun's surface.

The earth has a number of different layers:

- The inner core is solid iron and is surrounded by an outer core of hot molten rock called magma.
- The mantle surrounds the core and is about 1,800 miles thick. The mantle is made up of magma and rock.
- The crust is the outermost layer of the earth. The crust forms the continents and ocean floors. The crust can be 3 to 5 miles thick under the oceans and 15 to 35 miles thick on the continents.

The earth's crust is broken into pieces called tectonic plates. Magma comes close to the earth's surface near the edges of these plates, which is where many volcanoes occur. The lava that erupts from volcanoes is partly magma. Rocks and water absorb heat from magma deep underground. The rocks and water found deeper underground have the highest temperatures.

People around the world use geothermal energy to heat their homes and to produce electricity by drilling deep wells and pumping the hot underground water or steam to the surface.

RENEWABLE ENERGY IN INDIA

Renewable energy accounted for 18.37% of the total installed power capacity in India in 2017[1]. India set a target of producing 40% of its total energy needs through renewable sources by 2030, as stated in its Intended Nationally Determined Contributions statement in the Paris Agreement

The country has an installed capacity of

62,053 MWp of grid-connected renewable power as of 31 November, 2017. Wind power capacity is at 32,746 MW, making India the fourth-largest wind power producer in the world. Installed solar power reached 16,611 MW as of January 2018, through both solar parks as well as roof-top solar panels[1]. India currently has the third largest solar park in the world at Kurnool, Andhra Pradesh, with a capcity of 1000 MW. Large hydro installed capacity was 44.41 GW[3] as of 28 February 2017 and is administered separately by the Ministry of Power and not included In MNRE targets.

6. CONCLUSION

As you can see there are number of different alternative energy sources that are more than capable to replace currently dominant fossil fuels, The main advantage of these alternative energy sources is that they are ecologically acceptable energy sources, that unlike fossil fuels do not release large quantities of CO_2 and other harmful greenhouse gases into the atmosphere, causing global warming and climate change. In order to succeed in this world will need to stop relying on fossil fuels to satisfy its energy demand, and will have to focus on alternative energy sources, especially renewable energy sources, and make them more effective. Green future can only be renewable energy future, and many energy companies have become aware of that. The only question that still remains is how much more will we have to wait for this "green future" to happen?

7. REFERENCES

1.World Energy Assessment (2001). Renewable energy technologies Archived 9 June 2007 at the Wayback Machine., p. 221.

2. Armaroli, Nicola; Balzani, Vincenzo (2016). "Solar Electricity and Solar Fuels: Status and Perspectives in the Context of the Energy Transition". *Chemistry – A European Journal*.

3. "Power from Sunshine": A Business History of Solar Energy

4. *"Energy Sources: Solar". Department of Energy. Retrieved*

5. Ellabban, Omar; Abu-Rub, Haitham; Blaabjerg, Frede (2014). "Renewable energy resources: Current status, future prospects and their enabling technology". Renewable and Sustainable Energy Reviews.