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A Review paper on Renewable Energy Resources in India

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ABSTRACT: Renewable energy sources (RES), which are used to produce energy from natural processes, are now used to replace conventional energy sources to meet the growing energy needs around the world. Conventional energy sources are limited and on the verge of exhaustion. Sun is the source of all energies. The primary forms of solar energy are heat and light. Sunlight and heat are transformed and absorbed by the environment in a multitude of ways. Some of these transformations result in renewable energy flows such as biomass and wind energy. Renewable energy technologies provide an excellent opportunity for mitigation of greenhouse gas emission and reducing global warming through substituting conventional energy sources. In this article a review has been done on scope of CO_2 mitigation through solar cooker, water heater, dryer, bio fuel, improved cook stoves and by hydrogen.

KEYWORDS: Greenhouse gases, CO_2 mitigation, Sustainable development, Renewable energy sources.

I. INTRODUCTION

India is world's 3rd largest consumer of electricity and world's 3rd largest renewable energy producer with 40% of energy capacity installed in the year 2022 (160 GW of 400 GW) coming from renewable sources. Ernst & Young's (EY) 2021 Renewable Energy Country Attractiveness Index (RECAI) ranked India 3rd behind USA and China. In FY2023-24, India is planning to issue 50 GW tenders for wind, solar and hybrid projects. India has committed for a goal of 500 GW renewable energy capacity by 2030.In line with this commitment, India's installed renewable energy capacity has been experiencing a steady upward trend. From 94.4 GW in 2021, the capacity has gone up to 119.1 GW in 2023 as of Q4.

II. RENEWABLE ENERGY SOURCES

Renewable energy resources will play an important role in the world in the future. Energy resources have been divided into three categories: fossil fuels, renewable resources, and nuclear resources. Renewable energy resources are the resources from which energy can always be obtained, such as solar energy, wind energy, biomass energy, geothermal energy, etc., and are often referred to as alternative energy resources.

III. CLIMATE CHANGE SCENARIO

Climate change is one of the main concerns of humanity in the 21st century. Century. It may affect health in a variety of ways, including increases in the frequency and intensity of heat waves, reductions in cold-related deaths, increases in floods and droughts, changes in the prevalence of vector-borne diseases, and impacts on disaster risk and malnutrition. The overall balance of health impacts is likely to be negative, and populations in low-income countries are likely to be particularly vulnerable to the adverse effects. Experience with the 2003 heat wave in Europe has shown that high-income countries can also be affected. Potentially the most important environmental problem related to energy is global climate change (global warming or greenhouse effect). The increasing concentration of greenhouse gases such as CO2, CH4, CFCs, N2O and ozone in the atmosphere causes the heat radiated from the earth's surface to be retained and the earth's surface temperature to rise.

IV. SOLAR ENERGY

Earth gets 10,000 times more energy from the sun than the energy the whole world consumes. As for renewable energy sources, solar thermal energy is the most common and is available in both direct and indirect forms. The sun emits an amount of energy equal to 3.8×10^{23} kW, of which about 1.8×10^{14} kW is absorbed by the earth. There are numerous ways to use the available solar energy for thermal applications such as cooking, heating water, drying plants, etc.

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Solar cooking is the most direct and convenient application of solar energy. Solar energy is a promising option that can become one of the leading energy sources for cooking. There are different types of solar stoves, of which the box solar stove is widely used worldwide. A study conducted in Costa Rica and around the world compared the benefits and limitations of solar stoves with conventional wood and electric stoves. The payback period of a common hot box type solar stove, even if used 6-8 months per year, is about 12-14 months, saving about 16.8 million tons of firewood and avoiding the emission of 38.4 million tons of carbon dioxide per year.

Residential solar water heaters, which can provide most of the hot water needs of a family of four, offer significant environmental protection and should be used whenever possible for the sake of a sustainable future. It is estimated that a household solar hot water system with a capacity of 1001 per day at 50% utilization can save 1237 kg of carbon dioxide emissions per year, and as much as 1410.5 kg in hot and sunny regions.

Solar drying technology offers an alternative that allows vegetables and fruits to be processed in clean, hygienic and sanitary conditions according to national and international standards and without energy costs. It saves energy and time, takes up less space, improves product quality, makes the process more efficient and protects the environment.

Solar energy is a very important source of energy because of its advantages. There are many remote areas in the world where there is no electricity, but solar radiation is abundant, so using solar energy to generate electricity in these areas is quite feasible. A solar thermal power system is a device that uses solar radiation to generate electricity through solar thermal conversion; basically, the collected solar energy is converted into electricity through the use of a kind of heat-to-electricity conversion device.

The main component of any solar thermal system is the solar collector. Solar collectors are a special type of heat exchanger that converts the energy of solar radiation into the internal energy of the transport medium. After a historical introduction to the use of solar energy, the different types of collectors such as flat plate, parabolic trough, evacuated tube, Fresnel lens, parabolic dish and heliostat collectors are described. The cost of electricity generation by solar energy is much higher than that of a conventional power plant. In terms of carbon emissions, solar-based power plants release almost no carbon.

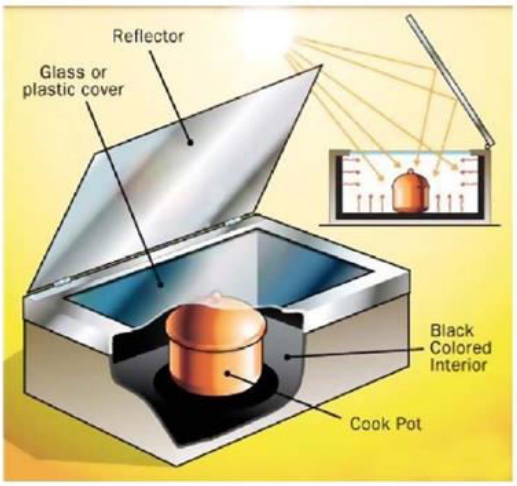

Fig. 1. Box type solar cooker

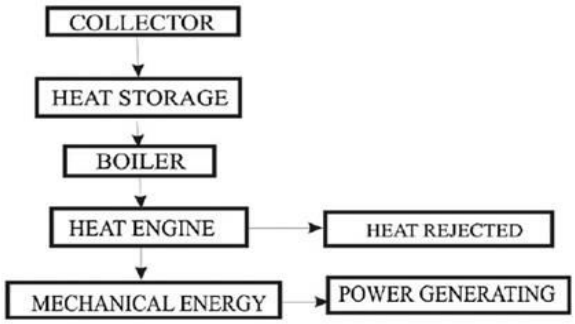

Fig. 3 Schematic diagram of a solar thermal conversion system

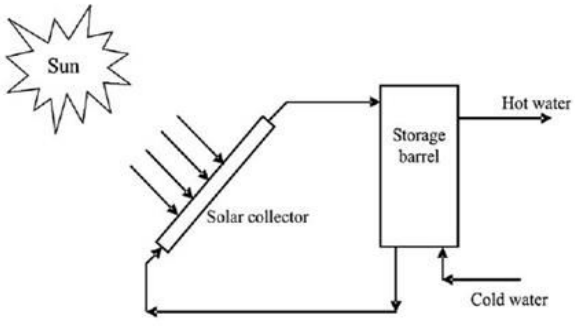

Fig. 2. A typical domestic-scale solar water heater

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V. WIND ENERGY

Wind energy for electricity generation is now a mature, competitive, and practically environmentally friendly technology that is widely used in many areas of the world. Wind energy converts the energy present in the wind into electricity or mechanical energy through the use of wind turbines. The purpose of a turbine is to convert the motion of the wind into rotational energy that can be used to drive a generator. Wind turbines capture the energy of the wind using aerodynamically shaped blades and convert it into mechanical rotational energy. The rotor blades of wind turbines use aerofoils to generate mechanical energy.

In energy-poor developing countries, wind energy is a viable source of electricity that can be installed and transmitted very quickly, even in remote, inaccessible, and hilly areas. Electricity generated from wind never runs out and does not increase in price. The electricity generated by these turbines could save several billion barrels of oil and avoid many millions of tons of carbon and other emissions. At an average wind speed of 4.5 m/s, the estimated value of the annual net CO2 emission reduction potential is lowest (2874 kg) for the GM-II model and highest (7401 kg) for the SICO model in the diesel substitution case. For the case of substitution with electricity at the same wind speeds, it is estimated to be 2194 kg and 5713 kg and 5713kg, respectively, for the two models mentioned above.

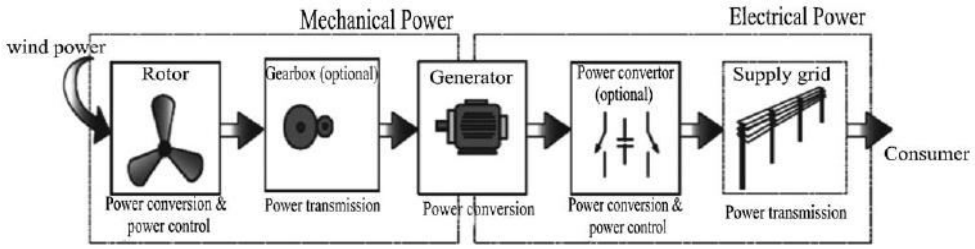

Fig. Conversion from wind power to electrical power in a wind turbine

VI. BIOENERGY

1.1 Biogas

The production of biogas by anaerobic digestion offers significant advantages over other forms of bioenergy production. It has been evaluated as one of the most energy efficient and environmentally friendly technologies for bioenergy production. A variety of feedstocks and digestion technologies can be used to produce biogas. This diversity and the different applications for the biogas and the fermented product lead to large differences in the environmental performance of the possible biogas systems. Feedstocks include organic waste from households and the food industry, dedicated energy crops, and agricultural waste products such as crop residues and manure.

Biogas is a gas mixture composed mainly of 40-70% CH4, 30-60% CO2, and 1-5% other gases. Methane formation is a complex process that can be divided into four phases: Hydrolysis, Acidogenesis, Acetogenesis/Dehydrogenation and Methanation .

1.2 Biomass Gasifier

A Gasifier is a device that converts solid fuels into gaseous fuels by thermochemical conversion. In the gasifier, low-grade fuel, i.e., biomass, is converted into high-grade fuel, such as charcoal, and further into low-calorific gas, called producer gas. The gas produced by the gasifier can be used to generate process heat for thermal applications. To popularize gasification technology in the field, the Ministry of New and Renewable Energy (MNRE) has taken the initiative to establish a research group in India for technology and manpower development, which has led to the establishment of a top Indian institute such as the Indian Institute of Science in Bangalore. The Energy and Resource Institute (TERI), Sardar Patel Renewable Energy Research Institute (SPRERI), etc. have been involved in the field of biomass combustion and gasification technology.

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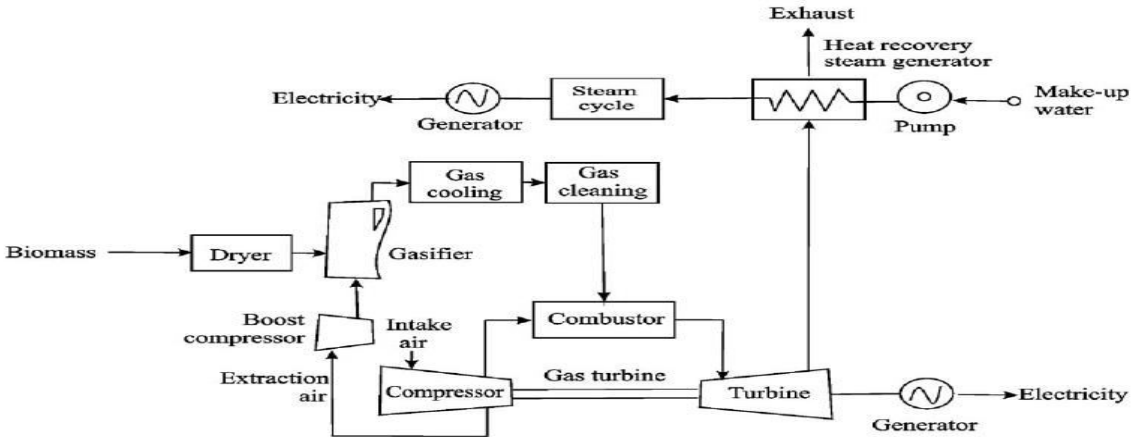

Fig. A biomass-gasifier/gas turbine combined cycle

VII. HYDROGEN AS FUEL

Hydrogen has fascinated generations of people for centuries, including visionaries such as Jules Verne. Hydrogen is expected to play a key role in the world's energy future by replacing fossil fuels. Hydrogen is gaining increasing attention as a promising energy of the future. Its conversion to heat or electricity is simple and clean. Combustion with oxygen produces no pollutants, only water, which can be returned to nature. However, hydrogen, the most common chemical element on earth, does not occur in nature in its elemental form. It must be separated from chemical compounds, by electrolysis from water or by chemical processes from hydrocarbons or other hydrogen carriers. The electricity for electrolysis could come from clean renewable sources such as solar radiation, kinetic energy from wind and water, or geothermal energy. Therefore, hydrogen can become an important link between renewable physical energy and chemical energy.

Most hydrogen is currently produced from non-renewable sources such as petroleum, natural gas, and coal. Thermo chemical conversion processes such as biomass pyrolysis and gasification have significant potential for renewable hydrogen production, which will benefit the use of biomass resources, the development of a highly efficient, clean process for large-scale hydrogen production, and the reduction of dependence on uncertain fossil energy sources. The main advantages of biomass for hydrogen production are:

1. The use of biomass reduces carbon dioxide emissions, so replacing fossil fuels with sustainable biomass fuels is an option to consider in reducing carbon dioxide emissions.
2.Conversion of residues increases the value of agricultural production.
3.The cost of MSW disposal is increasing as land resources are limited.

VIII. CONCLUSION

A comprehensive literature review was conducted on the major renewable energy devices used in the home and industry, such as solar water heaters, solar stoves, dryers, wind energy, biogas technology, and biogas gasifiers.

The review provides an overview of the development and scale of CO_2 mitigation for clean and sustainable development. Solar drying of agricultural products offers good potential for energy conversion in developing countries. Wind energy also offers good potential for minimising greenhouse gases if adequate wind potential is available. The paper specifically notes the potential to reduce greenhouse gas emissions depending on the use and availability of renewable energy sources and the fuels they replace.

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