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Green Energy Solution for Environment Pollution: Present Scenario in India

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ABSTRACT

Green chemistry, also called "sustainable chemistry" is an approach to chemistry that attempts to prevent or reduce pollution. It also tries to improve the efficiency of chemical products by changing how chemicals are designed, manufactured, and used. This chemistry emphasizes the reduction or elimination of the production of hazardous substances and the development of greener solvents and safer chemicals

This is the branch of chemistry that deals with the design and optimization the production and use of toxic substances.

Green chemistry aims to reduce the negative impact of the chemicals on human health and the environment. Chemists do this by developing alternative processes and reaction media, such as solvents, which are environmentally friendly, safer design of molecules and materials, reduce the waste generated from the production process, eliminate the hazardous products to impact the environment, minimize the dangerous materials used in various methods, which leads to environmental exploitation and optimum utilization of resources.

The manufacture of chemicals, such as drugs, can involve huge volumes of harmful solvents. So selecting greener solvents is a key target of many green chemistry programmes. Progress is being made towards identifying solvents that can be used in much smaller quantities, and careful selection can also increase the reaction rates and production rate.

Day by day, pollution which occurs from chemicals which are used in chemical industries or expelled from processing industries increasing constantly. To overcome this problem green chemistry is right option. By using green chemistry concepts, we can reduce the effects of environmental pollutants.

In this paper we are going to focus on the key principles of green chemistry like prevention of waste, avoiding the production of hazardous chemicals, designs of safe chemicals, incorporation of safe chemistry for the prevention of accidents.

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Introduction

Although chemistry is the science of matter but there can be no denying that in years past, and even at present, chemistry has been misused in many respects, such as the release of pollutants and toxic substances and the production of no biodegradable materials, resulting in harm to the environment and living things, including humans. It is now obvious that chemical science must be turned away from emphasis upon the exploitation of limited resources and the production of increasing amounts of products that ultimately end up as waste and toward the application of chemistry in ways that provide for human needs without damaging the earth support system upon which all living things depend. Fortunately, the practice of chemical science and industry is moving steadily in the direction of environmental friendliness and resource sustainability. The practice of chemistry in a manner that maximizes its benefits while eliminating or at least greatly reducing its adverse impacts has come to be known as green chemistry.

So the present situation required the solution to balance the use of natural resources and environmental conservation. From last two decades awareness for environmental protection has increased by using the concept of "green chemistry" which are less dangerous to human health and the environment.

The goal of green chemistry is to create better, safer chemicals while choosing the safest, most efficient ways to synthesize them, to reduce wastes and to eliminate hazards right at the design stage. To achieve this goal efficiently, chemists must be able to assess potential hazards of the chemicals that they develop. Green chemistry deals with risk by seeking to eliminate inherent hazard rather than by controlling exposure [1,2].

Definition of Green Chemistry

According to environmental protection agency, green chemistry is defined as "A chemistry that designs chemical products and

processes that are harmless to the environment. Chemical products should be made in such a manner that they do not remain in the environment at the end of their application and broken down into components that are harmless to environment".

Benefits of Green Chemistry [3-10]

1. Cleaner Air-Less release of hazardous chemicals to air leading to less damage to lungs.
2. Cleaner Water-Less release of hazardous chemical wastes to water leading to cleaner drinking
3. Safety - Increase safety for worker in chemical industry, less use of toxic materials, less potential for accident.
4. Benefits for Environment- Plants & animals suffer less harm from toxic chemicals in environment.
5. Lower potential for global warming, ozone depletion & smog formation.
6. Economy -Better performance so that less product is needed to achieve the same function.

Principles of Green Chemistry

Green chemistry takes into account the environmental impact and seeks to prevent or lessen that impact through several key principles outlined below [11].

Here are the 12 key principles of green chemistry as formulated by p.t. Anastas and j.c. warner, in green chemistry: theory and practice, 1998.

1. **Prevention:** It is better to prevent waste than to treat and clean up waste after it has been created
2. **Atom economy:** Synthetic methods should be designed in such a way to maximize the incorporation of all materials used in the process into the final product.
3. **Less hazardous:** Chemical syntheses wherever practicable, synthetic methods should be designed to use and generate substances that possess little or no toxicity to human health and the environment.
4. **Designing safer chemicals:** Chemical products should be designed to affect their desired function while minimizing toxicity.
5. **Safer solvents and auxiliaries:** The use of auxiliary substances (e.g. Solvents, separation agents, etc.) Should be made unnecessary wherever possible and innocuous when used.
6. **Design for energy efficiency:** Energy requirements of chemical processes should be recognized for their environmental and economic impacts and should be minimized.
7. **Use of renewable feed stocks:** A raw material or feedstock should be renewable rather than depleting whenever technically and economically practicable.
8. **Reduce derivatives:** Unnecessary derivatization should be minimized or avoided if possible, because such steps require additional reagents and can generate waste.
9. **Catalysis:** Catalytic reagents (as selective as possible) are superior to stoichiometric reagents.
10. **Design for degradation:** Chemical products should be designed so that at the end of their function they break down into innocuous degradation products and do not persist in the environment.
11. **Real-time analysis for pollution prevention:** Analytical Methodologies need to be further developed to allow for real-time, in-process monitoring and control prior to the formation of hazardous substances.
12. **Inherently safer chemistry for accident prevention:** Substances and the form of a substance used in a chemical process should be chosen to minimize the potential for chemical accidents, including releases, explosions, and fires.

Environment Protection

Renewable technologies are considered as clean sources of energy and optimal use of these resources minimize the environmental impacts, produce minimum secondary wastes and are sustainable based on current and future economic and societal needs. Renewable energy technologies provide an excellent opportunity for mitigation of greenhouse gas emission and reducing global warming through substituting conventional energy sources [12-14].

With the increasing of population, the energy source demands are also increases. The amount of energy requirement is different between the countries around the world. The developed country need more energy compare to developing country. The present people are most concern about renewable energy sources because it is pollution free, simply available and less costly and more amounts exist in the earth. In renewable energy technology we have to use the natural source of energy for example, solar radiation energy, wind energy, tidal energy, biomass energy and geothermal energy etc. This energy sources are environmental friendly in nature.

Environmental protection is a practice of protecting the natural environment on the individual, organizational or governmental levels, for the benefit of both the environment and humans. A concern for environmental protection has recurred in various forms, in different parts of the world, throughout history.

Our environment faces several problems, and many of these seem to be worsening with time, bringing us into a time of a true environmental crisis. It is more important to raise awareness of the presence of these issues, as well as what can be done to reduce their negative impact. In the environmental issues the most important form of global pollution are discussed below.

Global Warming: The emission of greenhouse gases due to human activity causes global warming, which in turn causes an increase in temperature that they leads to rising the sea levels, melting of polar ice caps, flash floods and desertification. With the increases of population the number of vehicles and industries increases and its increases the CO2 gas emissions so that the earth average surface temperature also increases. The main reason of global warming is greenhouse gas effect. Human activity since the industrial revolution has raised the amount of greenhouse gases in the environment [15].

For controlling the global warming it is necessary that control the air pollutant emissions from vehicles and industries.

What is Renewable Energy?

Renewable energy is energy derived from natural sources that are replenished at a higher rate than they are consumed [16]. Sunlight and wind, for example, are such sources that are constantly being replenished. For the most part, renewable energy sources also provide clean energy, or energy that emits few greenhouse gases or pollutants [12,17-19].

Out of all energy resources, we consider green power (solar, wind, biomass and geothermal) as the cleanest form of energy [20,21]. Clean energy is energy that, when used, does not pollute the atmosphere; creating little or no greenhouse gases.

Once again, there are clear crossovers between clean energy, green energy and renewable energy.

Here's an easy way to differentiate between them:

Clean energy = clean air

Green energy = sources from nature
Renewable energy = recyclable sources

Fossil fuels like coal, oil and gas when burned to produce energy, cause harmful greenhouse gas emissions, such as carbon dioxide [22].

Generating renewable energy creates far lower emissions than burning fossil fuels.
Renewable technologies are considered as clean sources of energy and optimal use of these resources minimize environmental impacts, produce minimum secondary wastes and are sustainable based on current and future economic and social societal needs. Renewable energy technologies provide an excellent opportunity for mitigation of greenhouse gas emission and reducing global warming through substituting conventional energy sources [23-31].

Benefits of Renewable Energy [32, 33]
Environmental and economic benefits of using renewable energy include:

- Generating energy that produces no greenhouse gas emissions from fossil fuels and reduces some types of air pollution
- Diversifying energy supply and reducing dependence on imported fuels
- Creating economic development and jobs in manufacturing, installation, and more.

Implementing on-Site Renewable Energy Projects: On-site power generation provides local governments with the most direct access to renewable energy [34-38]. In addition to the overall benefits, on-site projects also provide a hedge against financial risks and improve power quality and supply reliability. However, local governments considering on-site generation may face possible technical, financial, and regulatory challenges. To overcome these challenges, local governments can:

- Assess the availability of local renewable resources
- Consider the costs of different renewable technologies
- Examine the aggregate costs and benefits of on-site green power
- Consider permitting requirements for locations where the facility could be sited
- Involve local stakeholders, particularly concerning siting
- Assess available sources of financing and other incentives

Why it is Called Sustainable Energy? [39-41]

Here are five reasons why accelerating the transition to clean energy is the pathway to a healthy, livable planet today and for generations to come.

1. Renewable energy sources are all around us
2. Renewable energy is cheaper
3. Renewable energy is healthier
4. Renewable energy creates jobs
5. Renewable energy makes economic sense

Renewable Energy Sources– Which are available in abundance all around us, provided by the sun, wind, water, waste, and heat from the earth – are replenished by nature and emit little to no greenhouse gases or pollutants into the air [42,43].

Here are a few common sources of renewable energy

Solar Energy
Sunlight is one of our planet's most abundant and freely available energy resources [44]. The amount of solar energy that reaches the earth's surface in 1 h is more than the planet's total energy requirements for a whole year. Although it sounds like a perfect renewable energy source, the amount of solar energy we can use varies according to the time of day and the season of the year as well as geographical location. The rate at which solar energy is intercepted by the earth is about 10,000 times greater than the rate at which humankind consumes energy.

Solar technologies can deliver heat, cooling, natural lighting, electricity, and fuels for a host of applications. Solar technologies convert sunlight into electrical energy either through photovoltaic panels or through mirrors that concentrate solar radiation. The cost of manufacturing solar panels has plummeted dramatically in the last decade, making them not only affordable but often the cheapest form of electricity. Solar panels have a lifespan of roughly 30 years, and come in variety of shades depending on the type of material used in manufacturing.

Although not all countries are equally endowed with solar energy, a significant contribution to the energy mix from direct solar energy is possible for every country.

Wind Energy [45,46]
Wind is a plentiful source of clean energy. The wind energy is generally derived from air flow using turbine. The wind energy is transformed mechanical energy from turbine into electric energy. Wind energy is another cleaned energy source. Wind is actually a form of solar energy. Winds are caused by the heating of atmosphere by the sun, the rotation of earth, and earth's surface irregularities. For as long as the sun shines and the wind blows, the energy produced can be harnessed to send power across the grid. The world largest wind mill is generally placed in china its present capacity is 6000 mw.

Wind energy harnesses the kinetic energy of moving air by using large wind turbines located on land (onshore) or in sea- or freshwater (offshore).

Many parts of the world have strong wind speeds, but the best locations for generating wind power are sometimes remote ones.

Geothermal Energy
Geothermal energy is a renewable energy source because heat is continuously produced inside the earth. People use geothermal heat for bathing, to heat buildings, and to generate electricity. The geothermal field, however, the temperature of geothermal reservoir or the fluid pressure in the reservoir may decrease over time as fluids are produced and energy is extracted.

Geothermal energy is thermal geological energy; it is generated and stored into the earth. The geothermal energy is generally depends upon the geothermal gradient, which is generally depends upon the difference in temperature between the core of planet and its surfaces. The geothermal energy is one of the lower costs, easily available, sustainable, trust worthy and cleans energy.

Geothermal energy utilizes the accessible thermal energy from the earth's interior. Heat is extracted from geothermal reservoirs using wells or other means.

Reservoirs that are naturally sufficiently hot and permeable are called hydrothermal reservoirs, whereas reservoirs that are sufficiently hot but that are improved with hydraulic stimulation are called enhanced geothermal systems.

Once at the surface, fluids of various temperatures can be used to generate electricity. The technology for electricity generation from hydrothermal reservoirs is mature and reliable, and has been operating for more than 100 years.

Hydropower [47]

As a renewable energy resource, hydro power is one of the most commercially developed. By building a dam or barrier, a large reservoir can be used to create a controlled flow of water that will drive a turbine, generating electricity. This energy source can often be more reliable than solar or wind power (especially if it's tidal rather than river) and also allows electricity to be stored for use when demand reaches a peak. Like wind energy, in certain situations hydro can be more viable as a commercial energy source (dependant on type and compared to other sources of energy) but depending very much on the type of property, it can be used for domestic, 'off-grid' generation. The tidal energy is a generally form of hydropower, it convert the energy obtained from ocean tide to electrical energy. The tidal energy shown is obtained from earths oceanic tides. This is one of the cheaper, easily available and environmental friendly energy.

Hydropower harnesses the energy of water moving from higher to lower elevations. It can be generated from reservoirs and rivers. Reservoir hydropower plants rely on stored water in a reservoir, while run-of-river hydropower plants harness energy from the available flow of the river. Hydropower reservoirs often have multiple uses – providing drinking water, water for irrigation, flood and drought control, navigation services, as well as energy supply.

Hydropower currently is the largest source of renewable energy in the electricity sector. Hydroelectric energy is by far the most prevalent, accounting for 83% of the world's electricity generation from renewable sources.

The infrastructure needed to create hydropower can also impact on ecosystems in adverse ways. For this reason, many consider small-scale hydro a more environmentally-friendly option, and especially suitable for communities in remote locations.

Ocean Energy

Ocean energy derives from technologies that use the kinetic and thermal energy of seawater – waves or currents for instance - to produce electricity or heat.

Ocean energy systems are still at an early stage of development, with a number of prototype wave and tidal current devices being explored. The theoretical potential for ocean energy easily exceeds present human energy requirements.

Bioenergy [48]

Bioenergy is produced from a variety of organic materials, called biomass, such as wood, charcoal, dung and other manures for heat and power production, and agricultural crops for liquid biofuels. Most biomass is used in rural areas for cooking, lighting and space heating, generally by poorer populations in developing countries. This is the conversion of solid fuel made from plant materials into electricity. Although fundamentally, biomass involves burning organic materials to produce electricity, and nowadays this is a much cleaner, more energy-efficient process. By converting agricultural, industrial and domestic waste into solid, liquid and gas fuel, biomass generates power at a much lower economic and environmental cost. The biomass is organic matter derived from the leaving materials or organisms. Biomass contains stored chemical energy from the sun. Plants produce biomass through photosynthesis. Biomass can be burned directly for heating purposes and converted into renewable liquid and gaseous fuels through various processes. The biomass can transform into usable forms of energy like ch4 gas or ethanol or biodiesels.

Modern biomass systems include dedicated crops or trees, residues from agriculture and forestry, and various organic waste streams.

The environmental impact from the production of biomass energy is produced air pollutant like CO, CO2, NOx and particulate matter lower comparison to fossil fuels. A Energy created by burning biomass creates greenhouse gas emissions, but at lower levels than burning fossil fuels like coal, oil or gas. However, bioenergy should only be used in limited applications, given potential negative environmental impacts related to large-scale increases in forest and bioenergy plantations, and resulting deforestation and land-use change.

Hydrogen Energy

Hydrogen energy is a key role for energy generation and replacing fossil fuels. It is gaining more attention in the future energy source. This is a simple and clean energy source. The hydrogen gas is currently produced from oil, natural gas and coal. The hydrogen gas also produced from biomass by gasification and fast pyrolysis process.

Hydrogen is expected to play a key role as an energy carrier in future energy systems of the world. As fossil-fuel supplies become increases therefore the environmental pollution is also increases, hydrogen is likely to become the major chemical energy carrier. When most of the world's energy sources become non-fossil based, hydrogen and electricity are expected to be the two dominant energy carriers for the provision of end-use services. A transition era will bridge the gap between today's fossil-fuel economy and hydrogen economy, in which the non-fossil-derived hydrogen will be used to extend the lifetime of world's fossil fuels by upgrading the heavy oils. In future the hydrogen energy demand is gradually increased.

Current Scenario of Green Energy in India [16,49]

India is one of the largest coal consumers in the world and imports costly fossil fuel. Close to 74% of the energy demand is supplied by coal and oil. Therefore, there is an urgent need to find alternate sources for generating electricity. In this way, the country will have a rapid and global transition to renewable energy technologies to achieve sustainable growth and avoid catastrophic climate change. Renewable energy sources play a vital role in securing sustainable energy with lower emissions.

India has an enormous renewable energy sources. This is the first country around the world to set up a ministry of non-conventional energy sources in early 1980s. In India the renewable energy capacity is (excluding the large hydro) has reached 33.8 gw. In these renewable energy sources 66% comes from wind, solar energy participative 4.59% along with biomass and small biomass. India is the 3rd largest energy consuming country in the world. India stands 4th globally in renewable energy installed capacity (including large hydro), 4th in wind power capacity & 4th in

solar power capacity (as per ren21 renewables 2022 global status report) [50,51].

The availability of renewable energy sources is different from each state in India. **Tamil Nadu** is one of the largest sources of wind energy in India. Bhopal: **Sanchi**, a world heritage site located in the Raisen district of Madhya Pradesh. **Bihar** is set to become the country's first state to have two green energy efficient towns in **Rajgir** and **Bodh Gaya**. The towns will start getting solar energy through the first-of-its-kind renewable energy project from 2023.

Top 5 states in India for solar installations -
Rajasthan: Cumulative solar installation as 16353.07 mw. …
Gujarat: Cumulative solar installation as 8747.42 mw. …
Karnataka: Cumulative solar installation as 8018.60 mw. …
Tamilnadu: Cumulative solar installation as 6497.32 mw. …
Telangana: Cumulative solar installation as 4657.18 mw.
India develops first solar park at **Charanka village**. Rajasthan has topped in the installed capacity of solar energy in India with 7737.95 mw [ministry of new and renewable energy (mnre)]. The 50-mw solar thermal power plant was set up in **Naukh village** located in the Jaisalmer district of Rajasthan.

Adani green switches on India's first hybrid power plant. This plant in **Jaisalmer** is, the first ever wind and solar hybrid power generation plant in India.

Black & vetch was appointed by developer as solar as the owner's engineer for a 15megawatt solar photovoltaic (pv) plant located at **Charanka village** in Gujarat, India.

The Vindhyachal thermal power station in the Singrauli district of Madhya Pradesh, with an installed capacity of 4,760 mw, is currently the biggest thermal power plant in India.

Five largest solar power plants in India
1. Bhadla solar park, Rajasthan
2. Kurnool ultra mega solar park, Andhra Pradesh
3. Rewa ultra mega solar, Madhya Pradesh
4. Pavagada solar park, Karnataka
5. Np Kunta ultra mega solar park, Andhra Pradesh

India, faced with twin challenges on energy and environmental front, has no option but to work towards increasing the role of renewable in the future energy systems. Renewable energy technologies vary widely in their technological maturity and commercial.

Renewable electricity is growing at a faster rate in India than any other major economy, with new capacity additions on track to double by 2026. The country is also one of the world's largest producers of modern bioenergy and has big ambitions to scale up its use across the economy.

India already has a numerous policy measures in place that – if fully implemented – could address some of these challenges by accelerating the shift to cleaner and more efficient technologies. Subsidies for petrol and diesel were removed in the early 2010s, and subsidies for electric vehicles were introduced in 2019. India's robust energy efficiency programme has been successful in reducing energy use and emissions from buildings, transport and major industries.

Government efforts to provide millions of households with fuel gas for cooking and heating are enabling a steady transition away from the use of traditional biomass such as burning wood. India is also laying the groundwork to scale up important emerging technologies such as hydrogen, battery storage, and low-carbon steel, cement and fertilisers. A transition to clean energy is a huge economic opportunity. India is particularly well placed to become a global leader in renewable batteries and green hydrogen. To bring in a green revolution in the country, the government has set an ambitious target of having 500 gw of installed renewable energy by 2030, which includes the installation of 280 gw of solar power and 140 gw of wind power.

Sustainable development is possible by use of sustainable energy and by ensuring access to affordable, reliable, sustainable and modern energy for citizens. Strong government support and the increasingly opportune economic situation have pushed India to be one of the top leaders in the world's most attractive renewable energy markets. The government has designed policies, programs and a liberal environment to attract foreign investments to ramp up the country in the renewable energy market at a rapid rate.

The ministry of renewable energy provides financial support up to 50% of the cost to the state government implementers' agency for the development of tidal energy project. The cost of establishment of wind energy generation machine is high but the operating cost is also low. In India has a huge coastline with the gulfs and estuaries where the tides are strong enough to move turbines for the production of electricity. In India first geothermal energy power plant was established in Chhattisgarh Bal Rampur district under the connection of national thermal power corporation (NTPC) and Chhattisgarh renewable energy development agency (CREDA).

Conclusions

Renewable energy sources and technologies have potential to provide solutions to the long-standing energy problems being faced by the developing countries. The renewable energy sources like wind energy, solar energy, geothermal energy, ocean energy, biomass energy and fuel cell technology can be used to overcome energy shortage in India.

The conventional energy resources like oil, gas and coal are very important for the improvement in economical conditions of the country. In this study, the renewable energy strategy for sustainable development is key parameters for development. The renewable energy is a beneficial for environmental and health. The energy resources and their utilization are related to sustainable development. In energy technology storing of natural resources (fossil and nuclear) are focused to shifting renewable energy technology like solar energy, wind energy, tidal energy, geothermal energy, hydrogen energy and biomass energy.

All the factors like emission of greenhouse gases, availability of resources, land requirements, water consumption, social impacts and price of power generated are taken into consideration for the classification of renewable energy sources.

Energy security, economic growth and environment protectionary the national energy policy drivers of any country of the world. The need to boost the efforts for further development and promotion of renewable energy sources has been felt world overin light of high prices of crude oil.

Sustainable energy development strategies typically involve three major technological changes: energy savings on the demand side, efficiency improvements in the energy production, and

replacement of fossil fuels by various sources of renewable energy. Consequently, large-scale renewable energy implementation plans must include strategies for integrating renewable sources in coherent energy systems influenced by energy savings and efficiency measures.

Power generation from many types of renewables are 100% efficient in international energy statistics, while fossil power plants achieve only 25–85% efficiency.

There is an urgent need for the transition from fossil fuel energy systems to renewable resource energy systems to decrease reliance on depleting reserves of fossil fuels and to mitigate global climate change. Also, the expansion of renewable energy can improve air quality, reduce global warming emissions, create new industries and jobs, and help India move towards move cleaner and safer place where energy is affordable and in abundance. As we know covid-19 has a huge negative impact on the entire world but a positive note is that it has optimized the prospects of renewable energy sectors. The crisis has refocused the attention of the Indian government and policymakers to fight climate change and localize energy supply. Both these factors play to renewable power's advantage. Investors in conventional energy, suffering huge losses due to reduction of output and lower prices, are expected to accelerate the shift towards renewable power. Lastly, valuable lessons have been learned by grid managers in coping with increasing variability in power demand supply.

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