Ann. For. Res. 65(1): 11033-11050, 2022
ISSN: 18448135, 20652445

ANNALS OF FOREST RESEARCH
https://www.e-afr.org/

GROWTH OF GREEN ENERGY FOR RESTORATION OF FOREST

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Abstract:
Energy it cannot be generated or destroyed, energy is a quality of things that may be changed into other forms or transmitted to other objects. Energy that is generated with little harm to the environment is referred to as green energy. It is a renewable energy source. Green energy sources including solar, wind, geothermal, and hydropower are being developed and marketed as alternatives that either have little or no impact on global warming. Additionally, there are present applications for this new technology, including the heating and cooling of water as well as producing power for diverse uses. This research aims to investigate how increasing green energy is advantageous for forest restoration.

Keywords: growth, green energy, restoration, forest, renewable energy.

1. Introduction

Green energy has played a significant role in India's overall energy policy. It wasn't until the early 1970s that it became clear that renewable energy sources like solar and wind power would play a critical role in the eventual success of the movement toward energy independence [1]. Power generation, heating and cooling, transportation, and rural/off-grid energy services are the four main sectors where current renewable energy is being used more and more often. The Ministry of New and Renewable Energy (MNRE) in India has played a crucial role in facilitating the rollout of numerous initiatives, such as those aimed at producing electricity from renewable sources, reforesting rural areas to provide fuel for lighting, cooking, and transportation, and promoting the use of green energy in residential, commercial, and industrial settings. Additionally, it promotes the investigation, development, and diffusion of renewable energy technologies. The strategy to introduce new and renewable energy systems included subsidies, tax incentives, preferred tariffs, market processes, and affirmative action, such as renewable purchasing mandates [2]. The budgets for R&D, PR, and other forms of campaigning have been increased. Green energy is crucial for ensuring the reliability of future energy supplies, increasing diversity in the energy sector, expanding access to reliable energy, ensuring energy sustainability, and protecting the environment. Reforestation is expected to play an increasingly crucial role in the energy systems of the future. This section analyzes government initiatives and laws that aim to increase the use of renewable energy and suggests a set of guidelines that might be utilized to hasten the spread of this technology.

Renewable energy refers to any kind of energy that is replenished at a rate at least equal to its use by natural methods, such as that which comes from the sun, the earth, or living organisms. Natural resources such as biomass, sunshine, geothermal heat, hydropower, tides and waves, ocean thermal energy, and wind are all viable sources of renewable energy. Geothermal fields may be depleted if their heat is withdrawn at a faster rate than it is replenished by heat fluxes, and the rate at which biomass is utilized may surpass the rate at which it is created [3]. The rate, at which direct solar energy is used, however, has little effect on the amount of solar energy that ultimately reaches Earth. Since fossil fuels (including coal, oil, and natural gas) cannot be replaced fast enough to fulfill present needs, their usage is not sustainable. Because most developed nations do not depend on green energy as their primary energy source, it is typically considered an alternative. On meet their energy needs, they often turn to fossil fuels and nuclear power, both of which are nonrenewable. Solar, hydropower, wind, biomass, and geothermal power have all increased in popularity as a result of the 1970s energy crisis in the United States, decreasing fossil fuel supply, and the risks involved with nuclear power. Energy generated by the sun or other sources that can be replenished at least as fast as they are used up is called "renewable." These resources may be utilized indefinitely if consumption is kept to a sustainable level. Unfortunately, the consumption rate surpasses the regeneration rate for certain potentially green energy sources such as biomass and geothermal, leading to their depletion [4].

1.1 Green Energy

Green power originates from renewable resources such the sun, wind, rain, tides, plants, algae, and geothermal heat. The energy they provide is "renewable," meaning it can be renewed indefinitely without human intervention. Technologies such as solar, marine, wind, hydropower, bio-energy, geothermal, etc., are all being used to restore forests. Hybrids and other similar technologies are among the many green energy options available. Useful applications include [5]:

- Energy storage using renewable sources of power
- Predicting the availability of renewable energy
- Facilitating the timely transmission of power produced by renewable sources to end users

Because of the significant role that traditional energy sources like fossil fuels play in exacerbating the effects of global warming and climate change on Earth, we have introduced the notion of green energy as a means of mitigating these issues. The fundamental objective of creating Green sources of energy is to provide electricity while simultaneously minimizing energy waste and pollution. In accordance with the research of scientists who support the use of green energy, doing so may slow the pace of global warming. It's important to note that these alternatives are renewable, unlike fossil fuels [6].

1.2 Uses of Green Energy for Restoration of Forests

Green energy may be used in a variety of settings, including homes and businesses. Sunlight, or solar energy, is the most widespread kind of renewable energy. If you own or rent a building that gets a lot of sunshine, you may want to consider having solar panels installed. Wind turbines may be erected in other areas with sufficient wind to provide sustainable energy. Using this power, you may either pump water or charge the battery on your sailboat. The use of biomass as a renewable energy source is also widespread. It's put to work in the generation of power and in the transportation sector. Bio-energy refers to energy that is generated by decomposing organic matter. To the contrary, geothermal energy harnesses the Earth's inherent heat for applications as diverse as space cooling and heating and electricity generation. Renewable energy from the ocean is another crucial option. The ocean's waves, which are influenced by both the moon and the wind, are another source of this energy [7].

1.3 Why Green Energy?

Today, fossil fuels are the main source of energy for things like house heating and transportation. Coal, oil, and natural gas are all easily accessible and may be used to fulfill our energy demands, but these resources are finite. We're using them more quicker than new ones are being produced. Inevitably, there won't be any left. And because of issues with waste disposal and safety, the United States plans to shut down most of its nuclear power plants by 2020. Meanwhile, over the next two decades, America's energy demands are projected to increase by 33%. Alternatives like renewable energy exist to bridge this gap. Relying on renewable energy sources is preferable for the planet even if an endless supply of fossil fuels were available. Because they don't create too many harmful byproducts, renewable energy sources are generally referred to as "green" or "clean" energy. However, greenhouse gases are released into the atmosphere when fossil fuels are burned, trapping heat from the sun and contributing to global warming [8]. The majority of climate experts believe that global temperatures have increased during the last century. Scientists have warned that rising sea levels and the frequency of floods, heat waves, and droughts might be the result of this trend. When fossil fuels are burnt, other contaminants are discharged into the environment. The effects of these toxins on ecosystems and human health are devastating. Diseases like asthma may be exacerbated by the presence of pollutants in the air. Plants and fish are harmed by the acid rain produced by sulphur dioxide and nitrogen oxides. Smog is aggravated by a variety of factors, including nitrogen oxides. The use of renewable energy sources will also aid in achieving energy autonomy and safety. Money may be saved and energy security bolstered if we switched from using petroleum to using fuels derived from plant stuff, for instance [9].

1.4 Solar Energy

To put it simply, the sun is the earth's ultimate energy source. Despite the fact that just a billionth of the energy emitted by the sun reaches Earth, this is more than enough to power the whole planet. Actually, both renewable and nonrenewable energy come from solar energy that has been stored in various ways. Solar thermal and photovoltaic direct conversion processes are examples of sustainable energy practices. Since the sun will exist long after humanity has vanished from Earth, solar energy is a virtually limitless source of power. The challenge is in effectively using the energy. Heating using solar energy has been done for ages, and now we have the technology (photovoltaic cells) to utilize that heat to generate electricity. Radiant solar energy may be used in two primary ways: passively and actively. To harness the sun's rays, passive solar energy systems don't need any active mechanisms, such as motors or pumps. The energy of the sun may be harnessed and stored in buildings in a variety of ways. Glass lets in natural light and heat from the sun, while water and stone have significant heat capacities and are thus good material choices. They are capable of storing significant quantities of solar energy throughout the day for use later on after the sun has set. An example of a greenhouse that uses passive solar heating is one that faces south and is constructed from glass panes and concrete [10].

Mechanical equipment (such as solar panels) in active solar energy systems must be driven by an external source of energy in order to gather sunlight and pump fluids for storage and distribution. The best orientation for solar panels is a southerly or westerly one. Commonly, a solar panel will be a black matte box with a glass outside. There are coils of a liquid medium within that collects heat (usually water, sometimes augmented by antifreeze). Water is heated by the sun and then pushed through coils in a heat transfer tank. The heated water is either retained in the tank for later use or piped around the building to radiators and water closets. Power is created by the sun using photovoltaic cells. In order to generate the necessary amount of current, hundreds of individual cells are interconnected. Either the power is immediately put to use or stored in batteries. With no moving components, solar cells are reliable, quiet, and environmentally friendly. The high price of photovoltaic cells in the past made widespread adoption of solar panels impractical. Thanks to advances in low-priced semiconductor semiconductors, solar electric panels are now competitive with more established forms of energy generation. While the sun's rays themselves don't cost anything, the technology needed to harness them may be rather expensive. A home that relies on passive solar heating may cost more to construct. The technique requires more expensive glass and stone materials and superior insulation than are typically used in construction. In most cases, however, significant cost reductions become apparent when looking at power bills over an extended period of time. It may cost a lot to buy, install, and maintain solar panels for use in active solar energy systems. It might become pricey if there are any leaks in the complex system of pipes needed. One major limitation of solar power is that it may only be used during periods of bright sunshine [11].

1.5 Hydroelectric Energy

Using the motion of water to move generator turbines is the basis of hydroelectric power generation. Hydroelectricity is generated mostly by dams constructed on swift-moving rivers. It is possible to create a reservoir by damming a river. The difference in water level between the top and bottom of a dam stores energy in the form of potential. When water is let out of the dam via the penstock, the kinetic energy of the water turns turbines, generating power. Hydroelectric power, like other renewable energy sources, has a low total cost of ownership over the long term, despite substantial installation and maintenance costs up front. Now that the river can't carry as much water downstream, sediments that would have been carried by the river end up in the reservoir instead. If the silt builds up in the penstocks, the dam may lose its capacity to produce energy. Large dams often alter the local ecosystem in profound ways. When a river is first dammed, the rising waters behind it may flood farmlands and displace whole human and animal communities. Hundreds or maybe thousands of square kilometres might be flooded if the reservoir were to overflow. A reduction in water flow downstream from a dam might have unintended consequences for people and animals in the area. The dam may also prevent fish from swimming upstream to breed. The penstock and out-take pipelines are major choke points for aquatic life. The high rate of evaporation from the reservoir's vast surface area may significantly alter the weather pattern in the region [11-12].

Even though 45,000 large dams have been built, only about a quarter of them are really being used to generate hydroelectricity (e.g., irrigation, flood control, navigation and urban water supply schemes). Climate change is expected to increase global average precipitation and runoff, but regional patterns will differ; this means that while global effects on hydropower production are expected to be minimal, significant regional variations in river flow volumes and timing may present challenges for planning. One of hydropower's potential benefits is bolstering the stability of electricity systems. Flexibility in operation is a key feature of many storage hydropower facilities, making them an invaluable asset to electric power grids. Hydropower is useful for maintaining consistent electrical delivery because of its peaking capacity, power quality qualities, and fast reaction load-following and balancing capabilities. In a unified system, reservoir and pumped storage hydropower can keep the supply and demand in balance despite fluctuating demand or supply patterns, easing the load following burden on thermal plants. This, in turn, reduces carbon emissions. The integration of intermittent renewables like wind, solar photovoltaics, and wave power may be simplified with the use of storage and pumped storage hydropower [13].

1.6 Wind Power

Wind develops when the atmosphere is heated in different places by the sun at different rates. Because of their different thermal properties, warm air rises while cold air sinks. The word "wind" is used to describe this air current. For centuries, people have harnessed the wind for its energy potential. The water it pumps, the ships it propels, and the mills it grinds grain in have all benefited from its usage. Wind turbines are able to produce power in areas with consistent and strong winds. Wind energy is clean, may be infinite, and is cheap to generate. Aside from the initial investment and subsequent maintenance and repair bills, wind energy is completely free. Wind-powered generators have a number of problems, the most significant ones being their reliance on a steady supply of wind and a large amount of open space. Many people find windmills to be an eyesore and a source of noise, and some even go so far as to term them "visual pollution." Birds and insects on migration risk being caught in the moving blades and dying a horrible death. The area on which wind farms are constructed may, however, serve several functions, including agriculture, ranching, and even tourism.

1.7 Biomass Energy

Biomass, which includes anything from algae to trees to crops, is the substance that plants utilize to store the energy they get from the sun during photosynthesis. Bioenergy, also known as biomass energy, refers to the process of transforming biomass into usable types of power such thermal energy, electrical power, and liquid fuels. The biomass used to produce bioenergy may either be grown specifically for that purpose as "energy crops," or it can be derived from waste products of food and fibre processing, such sawdust and forestry byproducts, among other places. The clean component of municipal solid trash, construction and demolition wood pellets, and transportation pellets all contribute significantly as post-consumer residual streams (MSW). Managing the circulation of solar-generated materials, food, and fibre is essentially what the biomass-to-bioenergy system is all about. Biomass may be utilized to create energy in a number of ways, some of which include intermediary energy carriers known as biofuels. Charcoal (a solid fuel with a greater energy density), ethanol (a liquid fuel), and producergas (derived by gasifying biomass) all fall under this category [14].

Biomass fuel production causes environmental harm. If trees are felled without being restored, soil erosion might result. Lower rates of photosynthesis result in more carbon dioxide in the atmosphere, which may speed up global warming. Biomass burning not only releases carbon dioxide into the atmosphere, but also prevents the soil from absorbing nutrients that would have otherwise been produced by the decomposition of the organic waste.

Biomass accounted for around 10% (50.3 EJ/yr) of the world's main energy source. Biomass is used primarily for two different purposes:

- Low-efficiency: The impoverished people in developing nations often rely on conventional biomass fuels like wood, straws, dung, and other manures for daily needs like cooking, lighting, and warmth. Most of this biomass is burned, which has devastating effects on people's health and quality of life. Charcoal is gaining popularity as a supplementary energy carrier in rural regions, opening up new avenues for the development of supply chains.
- High-efficiency: Modern bioenergy takes use of more practical solids, liquids, and gases as secondary energy carriers to generate heat, electricity, combined heat and power (CHP), and transportation fuels for a wide range of industries. Liquid biofuels such as ethanol and biodiesel have potential use in vehicles and several industrial processes across the globe. Biogases generated by the anaerobic digestion of organic wastes and municipal solid waste may be used to generate electricity, heat, or both (MSW).

1.8 Biomass Energy Conversion Technologies and Applications

Whether at the residential (~10 kW), municipal (~100 kW), or industrial (~MW) level, there is a technology available to convert biomass into electricity, gas, or liquid fuels. Technologies are often categorized based on the kind of conversion process they use or the goods they generate [15].

1.8.1 Combustion

Even today, direct burning of biomass is the norm when it comes to converting biomass into usable energy like heat or electricity. New advances have led to the installation of more efficient heating systems that are automated, contain catalytic gas purification, and use standardized fuel, making widespread use of biomass-fueled heating systems in colder locations possible (such as pellets). Modern house heaters are an efficient upgrade over conventional fireplaces, with potential emission reductions of up to 90%. District heating powered by biomass is commonplace in the Nordic countries, Austria, Germany, and certain Eastern European states.

1.8.2 Gasification

Biomass might be turned into a fuel gas using a high-temperature thermochemical process. Gasification is the process of converting solid biomass into gaseous fuel by burning it in the presence of sufficient air for the transformation but not for total combustion. This high-temperature thermochemical reaction results in a gas known as producer-gas. Producer-gas is mostly composed of carbon monoxide, hydrogen, carbon dioxide, and nitrogen, and has a heating value of 4.6 MJ/Nm3 (15 percent of that of natural gas). The gasifier and its operating parameters are adjusted according to the size, texture, moisture content, etc. of the biomass being processed and the intended use of the resulting gas. Direct burning of these gases for heat or cooking is one option, while indirect combustion in the form of internal combustion engines or gas turbines may be used to power generators or propellers. Power production facilities linked to the grid may use hundreds of kg of woody biomass every hour to create 10–100 MW of electricity. Smaller systems (5–100 kW) can be used to cover the needs of a single home or neighbourhood.

1.8.3 Anaerobic digestion

Another way to convert biomass into a flammable gas is by anaerobic (without air) digestion, which takes place at low temperatures. Methane is a byproduct of the decomposition of organic matter, and the gas collected from landfills and anaerobic digesters is known as biogas. Biogas, which is around 60% methane and 40% carbon dioxide, has a thermal value of 55% that of natural gas. Biogas has been produced in large quantities from a wide variety of sources, including animal and human wastes, sewage sludge, agricultural scraps, carbon-laden industrial processing outputs, and landfill debris. You can think of an anaerobic digester as a tank with an inlet for introducing organic residues and other wastes, a tank where the biomass is heated to speed up its decomposition and partially convert by bacteria into biogas, and an outlet from which you can remove the bacterial biomass and any undecomposed material as sludge. Burning the resulting biogas may provide us with fuel for stoves and heaters, as well as electricity for our homes and businesses. Digestion has a low electrical efficiency overall but can handle wet biomass efficiently. Importantly, the process also has direct benefits that are unrelated to energy. A concentrated nitrogen fertilizer is created from the effluent sludge, which is heated to high temperatures in the digester tank to kill off any remaining microorganisms.

1.8.4 Liquid biofuels

Creating biofuels requires procedures that transform biomass into higher-value energy intermediaries. Many people are thinking about how they may switch from using petroleum-based fuels in their cars to using liquids made from solid biomass. However, it has proved to be a nontrivial task to integrate liquid biofuels with the existing fuel infrastructure and engine technology of the modern world. Small quantities of diesel have been replaced with substances produced by oil-producing plants such as soybeans, palm oil trees, and oilseeds like rapeseed. Marketed throughout Europe and to a lesser degree in the United States, "biodiesel" needs large subsidies to be competitive with diesel. Alcohols derived from biomass may stand in for traditional fossil fuels like gasoline and kerosene [2]. Ethanol obtained by the fermentation of biomass is now the most popular. Food crops like maize are used in the majority of ethanol production in affluent nations, whereas sugarcane is more typically used in the developing world. A lot of people use it to improve the octane of their gas or to lessen their reliance on foreign oil. The overall energy balance of such systems has not been especially advantageous, and ethanol production in the United States and Europe is still not competitive with the pricing of gasoline and diesel. Due to the great production of sugarcane, Brazil's Proalcool ethanol program has been effective from its inception in 1975, despite the continued need for subsidies. Methanol and hydrogen are two more biofuels with transportation applications. Both of these substances can be made by biomass gasification and might be employed in fuel cells in the future. Although ethanol production from agricultural products like maize and sugarcane has become commonplace and even lucrative on occasion, it is still susceptible to commodity price fluctuations in relation to the fuels market [3].

1.9 Geothermal Energy

The heat released by the Earth's inner geologic processes may be harnessed for use in either electric or thermal power production. Geothermal heat generates steam, which may be used as a source of energy. Groundwater travels through cracks in the Earth's crust until it reaches rocks heated by underlying magma, at which point it boils. This steam eventually reaches the surface again, manifesting as a geyser or a hot spring. Steam might be extracted from the reservoir by digging wells and then utilized to turn turbines that produce electricity. It is feasible to heat a building by recirculating hot water throughout the space. Geothermal energy is most abundant along the boundaries of tectonic plates. Because the western United States is the most favourable for geothermal energy sources, more than half of San Francisco's electricity originates from the Geysers, a natural geothermal zone in Northern California. California generates over half of the world's geothermal electricity. Iceland, a country located on a volcanic island chain on the mid-ocean ridge, uses geothermal energy to keep its cities warm in the winter. There are also geothermal power stations in the Rift Valley in East Africa. Geothermal energy may no longer be renewable in that location if steam is withdrawn faster than it can be restored or the heating source cools down. In the Geysers region of California, heavy consumption has already started to restrict energy output by cooling the underground heat source. Geothermal energy recovery has the potential to do less harm to the environment than the recovery of other energy sources. It has less negative effects on the environment than most other choices, but it's not very practical. Only on a very tiny fraction of the world's geography is the production of geothermal energy feasible on a commercial scale. Thus, it is very improbable that it will ever replace fossil fuels as a major energy source. In 2008, the primary energy source for the globe was about equivalent to the global technical potential of geothermal energy. In order to generate electricity, geothermal energy is predicted to have a technical potential of between 118 and 1,109 EJ/yr (to 3 km depth) (to 10 km depth). For direct thermal applications, the anticipated technical potential is between 10 and 312 EJ/yr. The average flux of 65 mW/m2 from the continental terrestrial heat flow may supply, at least in part, the heat required over the long term to achieve these technological potential. Given the potential for innovation in this area, there is no reason to slow down the widespread use of geothermal energy (for both electrical and direct applications). Whether or not geothermal technology potential is a limiting factor on a regional scale depends on the availability of EGS technology.

1.10 Wave Power

In deep water, ocean waves may carry enormous amounts of power. The intensity of the wave increases as a function of both its amplitude and its period squared. Energy fluxes typically average between 50 and 70 kWm-1 throughout the breadth of approaching waves, making waves with a long period (10 s) and big amplitude (2 m) of great importance for power production. There has been a long-standing interest in the potential for harnessing electricity from deep sea waves, and innumerable concepts for equipment to do so. In 1909, for instance, a wave power system was employed to light up a harbour in California. Interest has recently been rekindled, especially in Japan, the United Kingdom, Scandinavia, and India, and this has led to the development of technologies and the building of commercial facilities that can extract useful amounts of electricity. Maritime warning lights on buoys employ very small scale autonomous systems, while much bigger devices provide electricity to the grid. One apparent advantage is the ability to power maritime desalination operations. Scale of operation must be established, as is the case with other renewable energy sources, but recent developments point toward modest power output of about 100 kW-1MW using modular devices that capture energy from roughly 5 to 25 m of wave front. Initial plans call for implementation on or very close to the coastline to facilitate access and potentially reduce storm damage [6].

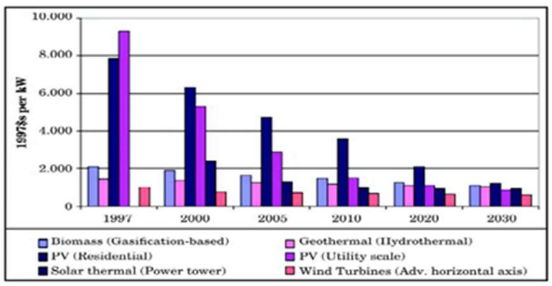

Figure 1: Optimistic estimates of renewable energy technologies' initial investment costs

Naturally, the overall cost of power generation also includes fuel prices and the cost of operation and maintenance, in addition to the initial investment. Green energy systems often have little or nonexistent fuel costs, however O&M expenses might be rather high. It's worth noting, too, that O&M expenses for any new technology will likely be expensive at first but will likely decrease significantly as familiarity and expertise grow. Compared to fossil fuel combustion systems, green energy systems like photovoltaics have a lot fewer mechanically active components and are therefore anticipated to have lower long-term maintenance costs. Levelized costs of power generation from these same renewable energy sources are projected by the U.S. DOE from 1997 to 2030.

1.11 Nuclear energy and the conflict with renewable

The nuclear power industry often asserts that nuclear energy is crucial in the fight against global warming. Obviously, you're mistaken. Greenpeace and other groups' research has shown that running nuclear power plants hinders the widespread adoption of renewable energy sources. Investment in nuclear power also diverts resources from renewable energy, where they may be put to better use combating climate change. Nuclear power's supposed ability to aid in the battle against climate change is based on a very erroneous premise. Even in the very unlikely event if the world's fleet of reactors was to be quadrupled, this would only result in a 6% decrease in global CO2 emissions and not until far beyond 2020, long over the deadline that climate scientists have set for preventing catastrophic climate change. The steady output required by nuclear power plants, known as "baseload," presents a significant challenge. Although this is not a benefit, the nuclear business promotes it as such. To reduce the high cost of generating energy, it is first necessary to have a constant power production mode that is not reliant on the actual requirement in the power grid. There would be a 100% increase in price if business hours were cut in half. This means that the 'base load' approach is more of a financial than a technological idea. Second, the demand curve must follow the operating mode of nuclear power plants, but contemporary gas turbines can respond within seconds to variable demand in the electrical system. Because of this, a lot of unnecessary energy is used. Expanding very inefficient electrical heating systems coincides with a significant proportion of nuclear power in the power mix in almost all nations with a winter heating need. On a frigid day in February 2012, for instance, France, which relies on nuclear power for roughly 80% of its energy needs, needed 101 GW of electricity, while neighbouring Germany, which has 15 million more people but only 20 GW of nuclear power, needed just over 50 GW [16].

1.12 Grid Renewable Energy

The share of renewable energy in India's total installed capacity has climbed from 7.8 percent in 2008 to almost 13 percent in 2014. Right now, renewable energy accounts for around 36.4% of India's total energy consumption. The country of India is the world's fifth largest producer of wind energy, with an estimated 23.7 GW of installed capacity. Small hydro power (4.1 GW), bio-energy (4.4 GW), and solar power (4 GW) account for the remaining capacity (MNRE, 2015). Roughly 70 billion kilowatt hours per year, or 70%, of the world's electricity needs are met by renewable energy sources (MNRE, 2014). Figure 1 displays the share of India's installed capacity that comes from renewable sources.

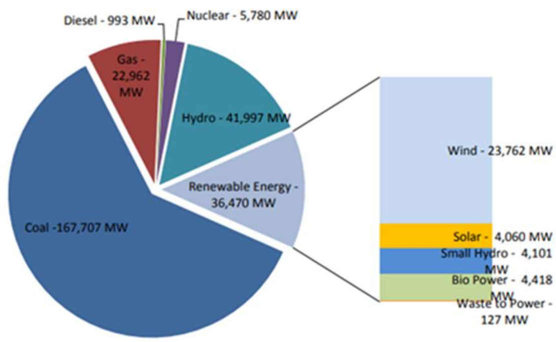

Figure 2: Renewables in total grid installed capacity

Every one of India's five-year goals has been met, and in many cases beyond, thanks to the country's consistent focus on expanding its green energy infrastructure. Revisions to the renewable energy goals set for 2022 were revealed recently. In Table 1 below, we see historical installed capabilities with the aimed-for figures in 2022. An effort of this magnitude in favour of renewable energy sources in India is without precedence.

Table 1: installed capacities of the past along with the numbers for the targeted capacity in 2022

Renewable Energy Source	Installed capacity by end of the 11th	Installed Capacity as on	Target as per 12th Plan	Revised targets by

	Plan (March 2012)	March 2015	(March 2017)	2022
Solar Power	941	3,383	10,941	100,000
Wind Power	17,352	22,645	32,352	60,000
Biomass Power	3,225	4,183	6,125	10,000
Small Hydro	3,395	4,025	5,495	5,000
Total	**24,913**	**34,236**	**54,913**	**175,000**

Source: MNRE

1.12.1 Solar

The Indian SPV business grew fast with the launch of the Jawaharlal Nehru National Solar Mission (JNNSM) in 2010. The majority of grid-connected SPV comes from ground-mounted, rooftop, and distribution-grid plants. Thanks to the establishment of institutional frameworks, national and local enabling mechanisms, targeted policies, and proper subsidies and financing arrangements, the total installed capacity has expanded from 40 MW in 2010 to 2686 MW as of 30 June 2014. The first phase of the JNNSM project added 1686 MW of capacity, while the second phase has added another 1000 MW (TERI, 2014-15). According to the Ministry of New and Renewable Energy (MNRE), as of June 2015, the combined capacity of all grid-connected SPV across all states was 4,060.65 MW. Following are some of the steps the government is doing to achieve this goal [7]:

- National Tariff Policy includes a provision for renewable purchase obligation (RPO) for solar electricity.
- Viability Gap Funding (VGF) for grid-connected solar power projects; GBI facility for packaged electricity; subsidies for off-grid applications;
- Constructing solar parks with a capacity of 1 MW along canal banks and solar-powered agricultural pump sets capable of providing electricity to 1 lakh pumps.
- Accelerated depreciation and tax holidays are offered, together with a waiver of import and excise taxes, for the installation of solar power plants.

The first phase of the program taught the government important lessons, such as the possibility of tariff reductions if the capacity to be assigned is considerable, the interest of experienced businesses in big projects, and the continued importance of the transmission and evacuation system. Aside from the importance of on-time payments and stability for the lender, indigenous manufacturers could use additional funding for research and development since the bulk of their equipment must be imported, driving up costs. Without a strong regulatory push, rooftop solar in India has been slow to take off, with just approximately 350 MW built (100 MW of total rooftop capacity). India's CSP installations have surpassed 225 MW, which is a significant milestone for the industry. In 2014, India brought online a 125 MW linear Fresnel plant, making it the world's biggest and accounting for 13% of worldwide additional capacity. The Dhursar CSP plant in Rajasthan is the biggest CSP installation in Asia, with a capacity of 125 MW. Another 50 MW plant in Andhra Pradesh was turned on for business in 2014.

1.12.2 On Shore Wind

Despite a 26% decline in demand from the previous year, India is now ranked sixth in the world for total installed capacity with its current wind power capacity of roughly 23,762 MW. Investment in wind power was stymied in 2012 due to the sharp depreciation of the rupee versus the US dollar and the elimination of major support measures. The market recovered, nevertheless, once the generation-based incentive (GBI) was reinstated retroactively in late 2013. When it comes to renewable energy sources, India has a home-field advantage in wind power because of the technology's maturity and scalability. Wind turbine production capacity in India is around 9.5 GW per year. In 2013, India added wind power capacity equal to 1.729 GW. In terms of installed wind power capacity, Tamil Nadu, Karnataka, Maharashtra, Rajasthan, and Gujarat are among the top states.

The Centre for Wind Energy Technology updated India's wind power potential in 2011 to 102,778 MW, assuming an 80-m turbine height and 2% land availability. The previous estimate was about 49,130 MW at 50 m height and 2% land availability, thus this is a big increase. Different approaches for mapping the wind resource have been used by different research groups to evaluate India's wind power potential in recent years. With a minimum capacity factor of 20%, the Lawrence Berkeley National Laboratory found that India's overall wind potential was 2006 GW at 80 m hub height and 3121 GW at 120 m hub height [8].

1.12.3 Offshore Wind

The approximately 7,600 kilometres of coastline in India are suitable for offshore wind power generation. The draft national offshore wind energy policy and draft cabinet note on the policy were produced by the Ministry of New and Renewable Energy and circulated to government departments for comment. The proposed law, if approved, would foster an environment conducive to the growth of offshore wind power. As a result, a proof-of-concept project may be implemented, boosting trust among potential backers of the technology.

The MNRE will create the National Offshore Wind Energy Authority (NOWA) to serve as the central governing body for all offshore wind energy projects in the country. Before beginning construction on an offshore wind energy project in the territorial sea, NOWA will perform resource assessment and surveys throughout the country's EEZs and enter into agreements with project developers. 12 Preliminary assessments along the coast have shown promise for offshore wind energy production along the coasts of Tamil Nadu, Gujarat, and Maharashtra. With over 7,600 kilometres of coastline, India has the potential to harness offshore wind energy at a 350 GW capacity.

1.12.4 Biomass

India's ability to produce power from biomass sources has increased because to the construction of megawatt-scale facilities to process biomass waste products such shells, husks, de-oiled cakes, and wood. The country generates between 120 and 150 million metric tons (MT) of agricultural and agro-industrial waste annually, according to the Ministry of New and Renewable Energy. Roughly 17,000 MW of biomass power is predicted to be produced from agricultural and agro-industrial byproducts. Rajkumar Impex Pvt. Ltd., a major Indian cashew processing company, is located in the city of Tuticorin, Tamil Nadu. Its biomass power plant, which uses cashew nut shells as fuel, can produce 6 MW, making it the first of its kind in India. The hamlet of Sohana in the Haryana district of Ambala is now home to a 1 MW biomass gasifier-based power facility erected by Chanderpur Renewable Power Co Pvt. Ltd. 8 A loan in the amount of'390 lakh was provided by the Indian Renewable Energy Development Agency (IREDA) to carry out the project [12].

1.12.5 Small Hydro

Approximately 19,750 MW of small hydropower projects are thought to be viable in India (MNRE 2012). In the Himalayan states, the potential lies mostly in river-based projects, whereas in other states, the potential lies primarily in irrigation canals. The MNRE has compiled a database of small hydro sites with 5,415 sites totaling 14,305.47 MW for projects up to 25 MW in capacity. Presently, SHP projects with a total capacity of 4,101 MW are active. SHP programs must be initiated by individual states. The government may choose to build a site directly, or it may lease or sell property to private developers who would then construct the necessary facilities. A total of 1419 MW of capacity was installed under the Eleventh Five-Year Plan, which is more than twice as much as the 536 MW added during the prior Ten-Year Plan. The Twelfth Five-Year Plan calls for an increase in capacity of 2,100 MW through SHP projects. Small and micro hydro projects, both public and private, may get funding from the MNRE. The federal government provides funding to states for a variety of purposes, including as the survey and production of comprehensive project studies, as well as the restoration and upgrading of existing SHP projects. This information is also useful for state governments as they formulate plans for the growth of SHP projects and the implementation of this potential. For both public and private businesses, the MNRE's CFA program provides funding for the renovation of older SHP infrastructure. Additionally, the SHP units are receiving technical support from the Alternative Hydro Energy Centre at IIT Roorkee [9].

1.13 Off-Grid Renewable Energy

To fulfill the energy needs of remote towns and places unlikely to be electrified anytime soon, the government is establishing distributed/decentralized renewable power projects employing wind energy, biomass energy, hydro power, and hybrid systems.

- Captive energy demands may be met by biomass heat and power plants and industrial waste to energy plants.
- Energy from biomass gasification for use in agriculture and industry
- Hydroelectric dams and other small-scale hydroelectric projects to power outlying settlements
- For mechanical and electrical purposes, particularly in areas without access to grid power, small wind energy and hybrid systems are a viable alternative.
- Solar photovoltaic (PV) rooftop systems to reduce reliance on fuel for electricity production in populated regions

The primary goals of the initiative are to develop the manufacturing base; demonstrate; field test; and demonstrate; field test; and assist RD&D to improve the reliability and cost-effectiveness of such systems.

Table 2: Off grid, captive power and other renewable energy systems

Green energy Source	**(CAPACITIES IN MW_{EQ})**
Waste to Energy	154.47
Biomass (non- bagasse) Cogeneration	591.87
Biomass Gasifiers (Rural)	17.95
Biomass Gasifiers (Industrial)	152.05
Aero-Generators/Hybrid systems	2.53

SPV Systems	234.35
Water mills/micro hydel	17.21
Total	1174.50

Source: MNRE 2015

1.13.1 Liquid Biofuels

In January 2003, as part of the Ethanol Blending Programme, oil marketing companies in nine states and four union territories were mandated to begin blending 5 percent ethanol with petrol. This mandate was later extended to cover the entire country, excluding only the Northeast, Jammu and Kashmir, and the island territories. However, the target of 10% blending was never met due to issues such as cyclical sugar output that increased ethanol production costs, the failure to agree on a price formula for ethanol, and procedural delays on the part of various state governments. Even when the government set the price at $4.4/litre, the ethanol market's response was underwhelming [6].

The Planning Comission launched the National Mission on Biodiesel made from non-edible tree-borne oils in 2003 to educate the public on the merits of this alternative fuel. In spite of the fact that jatropha is the primary ingredient in Indian biodiesel, other non-edible tree-borne-oils like karanja and pongamia, as well as animal fats like fish oil, are also used in the country's production. The Commission on Long-Range Planning has proposed raising the maximum allowable biodiesel content in high-octane gasoline from 5 percent in 2006–07 to 20 percent in 2011–12. By the end of 2013, 13.4 million ha were available for jetropha farming. India Railways, the country's state-owned rail operation, aims to mix up to 5 percent biodiesel into its locomotive fuel as part of its attempts to boost the biodiesel sector, which has been deregulated in India and now permits producers to sell directly to consumers [13].

In 1990, the capacity to generate electricity from renewable sources was 18 MW, and growth was modest until 2008. However, the sector has made great progress since then. This amazing growth is the result of a number of factors. Conventional power generation in India is being pushed forward by a number of factors, including demand/supply factors (low per capita consumption, large unelectrified areas; technological advancements and cost reductions in renewable technologies, entry of a large number of players), policy (targets set under the NAPCC, JNNSM, fiscal and other incentives), and other issues (fuel challenges, and significant potential for restoration of forests capacity addition). It is against this context that India has seen noteworthy progress in renewable technology during the last decade. Green energy capacity addition in India has grown at a CAGR of 18.41% from fiscal year 2007 forward, providing a window into the country's impressive economic development.

1.13.2 Key barriers of green energy

High cost of financing: Capital expenditures for renewable energy technologies are significant, but they have relatively low operational costs over a 25- to 30-year period. However, a substantial portion of the electricity price from these sources is attributable to the cost of borrowing (now ranging from 12-14%). By lowering borrowing rates, tariffs may be lowered, giving the technology a competitive advantage. If financing institutions see a bigger risk, they will demand more severe financial terms in exchange for their money. Green energy projects in India are more expensive than they would be in other countries because of the high cost and limited availability of finance.
Lack of enforcement of RPOs: State utilities and captive customers' adoption of renewable energy is mostly driven by the RPO (obligated entities). Investment in renewable energy sources may be encouraged with the help of the RPO regime. However, worries regarding the ultimate purchase of renewable electricity have arisen due to the absence of RPO enforcement. State discoms will need to take RPOs seriously, and state regulatory agencies will have to hold discoms accountable and impose penalties for noncompliance with purchasing commitments. States are letting obliged entities (such DISCOMs and captive customers) "carry on" deficits to the following financial year rather than requiring defaulters to acquire RECs (Renewable Energy Certificates) to compensate shortfall in electricity purchase. State RPO goals should be aligned with national goals.
Off taker risk: The distribution businesses' creditworthiness is a major factor in a PPA's capacity to get financing (Power Purchase Agreement). Few discoms can say they are financially stable. Discoms are at greater risk of off-taker default and late payments when their financial situation is precarious. Inadequate financial resources mean that utilities cannot fulfill their obligations and reduce the efficiency of renewable energy deployment tools. Recently, Uttarakhand's discom was fined by the state's ERC for failing to meet its renewable power requirement (RPO). Taking such measures is critical to ensuring the viability of the renewable energy industry.
Intermittency: In general, renewable energy is only practical as a supplementary or temporary power supply. The predictability of renewable energy may vary from source to source due to factors such as its features (natural fluctuations in output, such as wind availability increasing during monsoon and dropping down during other seasons) (e.g. sudden drop in wind power). In order to successfully integrate renewables into the grid, it is necessary to do the following: predict the amount of energy that will be generated from renewable sources, coordinate the development of projects, plan and strengthen the grid to accommodate renewables, aggregate RE generation over larger regions to reduce variability and uncertainty, create a market for flexible capacity, spinning reserves, and ancillary services, and define RE grid integration standards and regulations. Due to a lack of suitable evacuation facilities, new generation has been delayed or only partially commissioned, and generation has been cut down during peak hours. Considering the dismal condition of the evacuation systems, banks and other financial organizations are increasingly hesitant to provide money to renewable energy projects. Given that renewable resources are often situated in remote areas, getting them connected to the grid presents a significant issue. It is the responsibility of the RE developer to provide the necessary infrastructure for electricity evacuation from RE plants, even if governments are obligated to do so [15].

Permits and Land acquisition: The developer's process of obtaining permits, clearances, and other administrative approvals has to be simplified, sped up, and standardized. Particularly relevant are issues of securing appropriate permits and acquiring land. The regulatory procedures and the incapacity of state governments to give an efficient single-window clearance to developers have presented significant obstacles in the acquisition of land, a crucial part of infrastructure development. Time and expense overruns have resulted in high transaction costs due to a lack of cooperation among important organizations such as the tax department, the state pollution control board, and grid operators. Green energy companies would benefit from a streamlined approach that sets a time limit for obtaining all necessary permissions from the relevant state government agencies.

Financing for off grid power: The subsidy system for stimulating investment in the off-grid energy industry has been hampered by a variety of obstacles, which have prevented it from expanding. Subsidy approval is a lengthy bureaucratic process that requires a lot of documentation. Even Nevertheless, subsidies are sometimes either late in coming or never arrive at all. Business activities are hampered because of the lack of cash flow caused by such delays. Loans for off-grid businesses have their own set of difficulties. Extremely high interest rates of 13–18% are common in the local market, while restrictions restrict the use of foreign loans to certain projects. Because of the tiny amount of the loans, most banks are unwilling to provide financing, even at higher interest rates.

2. Future Scope

Green energy has a promising future in almost every sector of society, including manufacturing, agriculture, healthcare, the home, and more. As nonrenewable energy sources continue to run out, scientists are hard at work developing new renewable energy sources like radiation and biomass to replace the ones we've already discovered. Researchers are already hard at work on ways to make solar panels more efficient so that they can function even in overcast weather. There will soon be solar/wind hybrids, a new kind of renewable energy that combines solar and hydro. Wind turbines and solar photovoltaic panels work together in this innovative system to generate more power than ever before; tests have shown that this system is roughly twice as efficient as current methods. Similar technologies include those for which we have complete descriptions or just conceptualizations. Thanks to these innovations, we can create a society that relies entirely on renewable energy sources while still being kind to the environment.

3. Conclusion

Through this paper we are trying to draw attention to the need for advanced technology to fully harness the potential of green energy, which is both renewable and non-polluting. Since the planet may be saved and reliance on almost extinct nonrenewable resources lessened if natural resources are used instead. Looking to the future, green energy offers an alternate power source that can provide energy in an infinite number of forms. People only need to be made aware of the need of energy and environmental conservation. This is a first step in producing various types of energy in most fields using environmentally friendly means. There is a growing need for environmentally safe power, and cutting-edge green energy solutions will provide it. It will take some time, however, before every home can power its electronics with renewable energy sources like solar panels, wind turbines, and the like.

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