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Study of India's Rural Development through Renewable Energy Sources

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ABSTRACT

The rural sector, which is home to the majority of the country's people, must be strengthened if the country is to progress. Infrastructure, village electricity, mechanisation, and other methods should all be employed to make development. Villages in several states face a challenge with centralised generation and distribution systems since grid access is either impossible or too expensive. Power generating, cooking, irrigation, and water heating in rural areas can all benefit from renewable energy sources found in nature. The Indian government has come up with fresh plans and financial assistance for the implementation of such projects at the national and state levels. There are various technologies that can be used to improve the quality of life in rural areas.

Keywords-- Source of Energy, Rural Development, Rural Renewable Energy, Financing Landscape

I. INTRODUCTION

In a developing economy, eradicating poverty and enhancing the quality of life, energy is essential. It directly contributes to the fulfilment of both basic and more advanced human needs. About 40% of India's population does not have access to modern energy, despite the country's comprising one sixth of the global population. Only 30% of rural households have access to electricity or modern cooking fuels. In rural regions, kerosene is used for lighting and biomass fuels, such as wood, animal dung, and agricultural leftovers, are used for cooking. Social and economic growth and the lives of the poor are negatively impacted by a lack of access to modern energy sources. A high priority is being placed on rural electrification by the government in order to achieve its economic, social, political and regional development goals. Fossil fuel grid extension is a major source of energy in India, but it has a number of drawbacks, including environmental constraints and a higher price. For rural locations, the centralised grid system isn't always the best option because it's more environmentally damaging and requires a lot of infrastructure. In response to these issues, new technologies such as solar and wind power have emerged. According to studies, rural areas would be better served by installing a distributed, renewable energy system than by expanding the transmission grid from a centralised one.

The country's long-standing energy difficulties may be alleviated through the development of new renewable energy sources and technologies. India's rapidly expanding economy necessitates an energy source that can be relied upon. In India, renewable energy sources like wind, sun, biomass, tides, geothermal, and tidal can be exploited to alleviate the country's energy crisis. Renewable energy sources currently provide enough power for 33% of Indian households. This paper covers India's current energy consumption status, the potential of renewable energy sources, and their diverse rural applications, all covered by this paper.

Energy Trends in India is one of the densely populated nations of the world with a population of more than one billion. In the coming decades, India will face energy shortages critically due to increase in energy prices and energy insecurity. India had a GDP growth rate of 9% for the fiscal year 2007-2008 which makes it the second fastest emerging economy after china in the world. So there is an increasing demand for energy, which is currently satisfied mainly by coal, foreign oil and petroleum. These sources being non-renewable do not offer a permanent solution to the energy crisis and have negative impacts on environment. The time has thus come for the booming Indian economy to switch from non-renewable sources to renewable sources so as to achieve energy security.

The development and use of renewable energy sources and technologies are important for sustainable economic development of India. The expert consultation at Asia energy vision 2020 organized under world energy council agreed on energy demand projection in India.

II. SOURCE OF ENERGY

After China and the United States, India's total primary energy consumption has ranked third since 2013 (see world energy consumption) (see energy in the United States). In 2017, India was China's number two coal consumer. After the United States and China, India consumed 22.1 crore (221 million) tonnes of oil in 2017. Nearly half of India's primary energy needs will be met by imports in 2019.

Coal

In this financial year, coal and lignite production was at 73.1 million tonnes. [9]. [10] With 294.2 Mtoe,

India was the world's fourth-largest coal producer in 2017. 7.8 percent of the global market). India gets more than 80% of its energy (both utility and captive) from coal, which is also the main source of its greenhouse gas emissions (GHG).

According to Greenpeace, Jharia is home to India's largest coal belt. Jharia used to be covered in forests where several ethnic groups lived before coal mining began. The coal mines were taken over by the government in 1971. The Jharia coal mines were acquired by Bharat Coking Coal Limited (BCCL).

According to the United Nations, India has the highest concentration of coal seam fires in the world. An area around a mine is polluted with air, water, and soil.

For example, in 2019, the Central Government owned around 75% of Coal India Limited, which supplied about 84% of the thermal coal in India.

Due to a lack of high-quality coking coal resources suitable for iron and steel manufacturing in India, the country imports coking coal from other countries. Non-coking coal is also used in the sponge iron route to create iron and steel that isn't dependent on coke or natural gas.

Electricity

India generated 1,383 TWh of electricity in fiscal year 2019–2020, and 99.99 percent of the population had access to electricity.With a 4.8 percent share of global electricity production in 2013, India overtook Japan and Russia as the world's third-largest electricity producers. In 2019, hydropower generation in India will be the world's sixth largest.

Renewable energy sources account for 136 GW, or 38%, of India's total installed capacity. It's one of the world's leading investors and installers of renewable energy. India has set a renewable energy capacity goal of 175 GW by 2022.

A total of 100 GW capacity from solar energy sources, 60 GW from wind power and 10 GW of biopower capacity would be included in this total.

Liquefied Petroleum Gas

In the household sector, over 1 crore (10.937 million) tonnes were utilised in the household sector between April and September 2019 (six months), primarily for cooking. There are 274 million home connections (one connection for five people) and more than 400 million LPG cylinders in circulation, whose net aggregate length would constitute a 2,00,000 km long pipe system that is longer than the length of all Indian railway track. Currently, India is the world's second-largest LPG customer. The vast majority of LPG consumption is imported. In India, considerable progress has not yet been made in the development of piped city gas supplies.

Oil and Natural Gas

In 2017, India was the world's third-largest crude oil user, with 221 million barrels (4.8 percent of the world's total). India was the second-largest net crude oil importer in 2019 with a total of 205.3 Mt. The crude oil refining capacity of India, which was ranked fourth internationally in 2017, is 49.72 lakh (4.972 million) barrels per day (5.1 percent of global capacity).

III. DEVELOPING INDIA'S RENEWABLE ENERGY

Increasing the use of renewable energy sources and implementing energy conservation measures can lead to a sustainable energy supply. With a focus on becoming a global leader in sustainable energy production, India is on a mission. Installed hydroelectric and renewable energy capacities stood at 42.5% and 36.5%, respectively, as of October 2015, with an overall installed thermal capacity of 195.6 gigawatts (GW). From 2010 to 2015, nuclear energy capacity stayed largely unchanged at 5.8 GW. As part of the 12th Five-Year Plan, China plans to add 88.5 GW of new power capacity, which includes 72.3 GW of thermal power, 10.8 GW of hydropower, and 5.3 GW of nuclear power.

Table 1: India's untapped potential for renewable energy

S. No	Source	Power (MW)
1	Wind	45000
2	Biomass / Energy	25000
3	Small Hydro	15000
4	Solar Photovoltaic Cell & Solar Thermal Energy	35/km^2

In 2007, renewable energy sources accounted for 7.7% of total installed electrical capacity. The importance of our country's energy supply has been widely acknowledged.As of this writing, only roughly 3500 MW of the expected 100,000 MW of renewable energy has been utilised. For renewable energy investment, private sector applications are the primary source of funding. The government has launched a number of programmes and regulations to help the renewable energy industry.

In the country's 11th five-year plan, renewable energy is planned to provide 10% of India's total power generation capacity by 2012 and 4% of its overall

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electricity generation. This shows that renewable energy is increasing at 20 percent of the 70,000MW of additional capacity anticipated in the 11th five-year plan will come from renewable sources.

Wind

Wind power is a renewable resource. Wind is an abundant source of renewable energy. At the end of 2006, the world's total wind capacity was approximately 72,000 MW. Aside from the obvious environmental benefits, wind energy is gaining popularity in developing countries due to its ease of installation in remote places with a high demand for electricity. The world's fastest-growing renewable energy source is wind power. Due to decreasing costs, technical breakthroughs, and increased revenue for landowners, tax jurisdictions, and consumers globally, installed capacity is increasing at a rate of nearly 30% annually. In many cases, if fossil fuel sources are few, it may be a cost-effective alternative. As an additional benefit, wind energy can be used to augment diesel power (which is typically more expensive) or to provide farms, residences, and other installations on a one-to-one basis in distant places throughout the world. Depending on where you live, wind power may or may not be an option. Wind resources can be tapped in places where the wind power density is at least 400 W/m2 at 30 m above the ground. 211 wind monitoring stations covering 13 states and union territories, including the Andaman and Nicobar Islands, Andhra Pradesh, Gujarat, Karnataka, Kerala, Lakshadweep, Madhya Pradesh, Maharashtra, Orissa, Rajasthan, Tamil Nadu, Uttaranchal, and West Bengal, have recorded an annual mean wind power density greater than 200 W/m2 at 50 m height. The estimated 45,000 MW wind power potential of India. Up until the 31st of March of this year, wind generated an additional 8757 MW of power. Wind generating capacity in India ranks seventh in the world. Off-grid wind power generators in India come in a variety of shapes and sizes. Water-pump windmills, aero-generators (small wind electric generators with a capacity of up to 30 kW), and wind–solar hybrid systems are all options for generating electricity. What's required to build the best possible wind farm is a set of prerequisites like these:

- This location has a lot of wind power.
- An ideal location with healthy soil is essential.
- The availability of sufficient land
- There is a reliable electrical grid in the area.
- Access to the location for maintenance purposes
- Experimentation-based design
- Specific turbines were chosen due to their efficiency and cost.

Biomass Energy

Organic non-fossil material derived from biological organic compounds, such as wood, can be used to produce biomass, biogas, liquid biofuels, and municipal waste. Biogas is a gas mixture produced by methane-based bacteria acting on biodegradable materials in an anaerobic environment and contains methane, carbon dioxide, and trace amounts of other gases. Sugarcane biogas in agriculture, pulp and paper leftovers in forestry, and manure in live store residues are some of the other frequent forms of biomass. India's biomass resources and its potential.

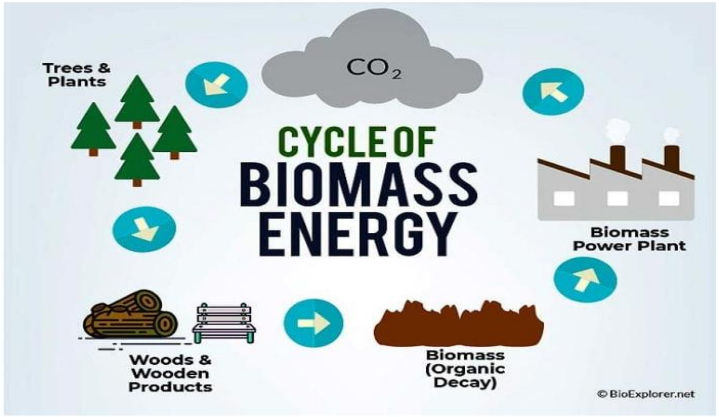

Figure 1
Source: https://www.bioexplorer.net/biomass-energy-pros-cons.html/

Biomass energy production often involves one of the following techniques:

1. Combustion
2. Gasification
3. Ration for the fermentation process
4. Digestion by anaerobic bacteria

More than 5000 million units of power and more than 10 million man-days of employment are generated in rural India each year with investments of Rs. 600 crore.

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Table 2: States in India's biomass sector

Indian States	Potential(MW)
Andhra Pradesh	200
Bihar	200
Gujarat	200
Karnataka	300
Maharashtra	1000
Punjab	150
Tamil Nadu	350
Uttar Pradesh	1000

Biogas can be used for a variety of things in rural areas, including:

- Cheap fuel can be used for any heating application, including cooking.
- Purpose of lighting
- To run any form of heat engine, either mechanical or electrical power can be generated.
- As with natural gas, compressed biogas can be used to power cars.
- An great fertiliser, bio-slurry

Hydro Power

The term "hydroelectric power" simply means "water-generated energy" (flowing in rivers etc.). Watermills, textile machines, and hydroelectricity are all examples of hydropower, a renewable energy source that utilises the potential or kinetic energy of water to produce mechanical energy or electrical energy. The turbine of a hydroelectric power plant is turned by a penstock, which transports the dam water. It is attached to a generator that converts water kinetic energy into electricity. Figure 1 depicts a typical hydropower generation facility.

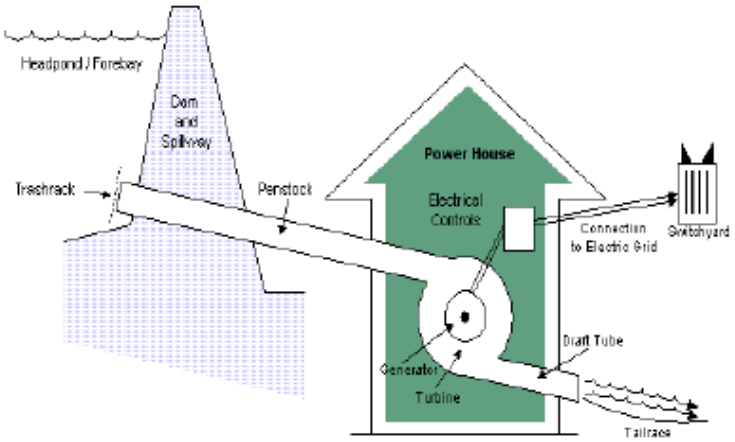

Figure 2: Hydropower generation plant

So far, just 17% of the 150000MW of hydroelectric potential has been utilised. A study by the Central Electricity Authority (CEA) [2] shows that India has the world's fifth-best hydroelectric potential. With a total capacity of 148700MW, India has a wealth of commercially viable hydropower.

Hydro power stations having a capacity of up to 25MW are considered minor hydro power stations in India (SHP). About 11% of India's estimated 15000MW SHP potential has been exploited to date. Support for SHP projects is provided by the Ministry of New and Renewable Energy (MNRE). A total of 1705 MW of SHP capacity has been added so far, thanks to the installation of 532 projects. In addition, 205 SHP projects totaling 479MW are now under construction.

Solar Energy

Direct and indirect types of solar energy are available for usage on the planet, and they can be accessed through solar radiation, wind, biomass, hydropower, and oceans. The thermal route uses the heat for water heating, cooking, drying, water purification, power generation, and other applications; the photovoltaic route converts the light in solar energy into electricity, which can then be used for a variety of purposes, such as lighting, pumping, communications, and power supply in un-electrified areas. Many industrial and agricultural processes (such as drying

and curing, regeneration of dehumidifying agents, seasoning of wood, and leather tanning) as well as space heating use solar air heating technology. Various types of solar dryers have been developed for use in various situations, including space heating. It is possible to store and then utilise solar energy. In rural areas, street illumination can also be accomplished by utilising this stored energy. Solar thermal energy is one of the most common types of renewable energy in India. It is mostly used in solar water heaters, solar cookers, and solar power systems.

By promoting all forms of solar power and increasing the percentage of renewable energy in the Indian market, India's MNRE and the Indian Renewable Energy Development Agency (IREDA) are working together to achieve these goals. R & D, demonstration initiatives, government subsidies, and private sector ventures are all being used to promote this new technology. The National Action Plan on Climate Change (NAPCC) was released by the Prime Minister on June 30, 2008. There are eight missions planned, including a National Solar Mission, which is part of the overall strategy. It is believed that India has a solar thermal power potential of between 20 and 35 MW/km2 and this is being utilised by the Ministry's Solar Energy Program, which is one of the largest in the world. According to estimates, India has 140 million m2 of collector area available for solar water heating systems. For fiscal years 2005–2006 and 2006–2007, the government has introduced a programme to promote the construction of an additional 1 million m2 of collector area for the development and deployment of solar water heating systems throughout the residential, industrial, and commercial sectors. In addition to financial and promotional incentives, the programme provides a variety of extra support measures for participants. As well as solar air heating and drying systems, the federal government also offers financial assistance for solar concentrating systems. Energy efficiency is a top priority for the MNRE and the state government of Himachal Pradesh, which has actively encouraged the use of passive solar architecture in new construction. The Ministry's Solar Photovoltaic Program (SPV), which has been in place for the past two decades, is focused on rural and remote locations. Following the success of the SPV demonstration and use programme during the Ninth Plan (2002–2007), it is proposed to continue it during the Tenth Plan (2002–2007) with certain modifications. All of them should have renewable energy sources available to them by the year 2010, according to Ministry goals.

Advantages

- It is a renewable, natural, and completely free resource.
- It's easy to get your hands on.
- It doesn't cause any environmental harm.
- In terms of carbon dioxide emissions, it's completely carbon neutral.
- A self-sufficient society can be achieved in most (sunny) places thanks to solar energy.
- Using solar energy means you won't have to deal with the politics and price instability that are becoming more and more common in fossil fuel markets.
- It doesn't have the same impact on forests and ecosystems as most other fossil fuel extraction methods.

Disadvantages

Seasonal/weather-dependent—therefore they may not be used all the time.

- Effective use requires a large investment of time and money at the outset.
- Battery banks that store energy during the day can be used at night, despite the fact that solar systems don't produce electricity at night.
- There is still a long way to go until solar energy storage technology reaches its full potential.
- It's difficult to store solar panels because they're so large. This is especially true of classic silicon crystalline wafer solar modules with higher efficiency.

IV. INDIA'S RURAL RENEWABLE ENERGY STATUS

The status of rural renewable energy systems around the world. India stresses how important it is to give their rural communities access to modern energy services by making use of renewable energy.

Using a distributed renewable energy system, basic electric service has been made available to more than 3000 previously unreachable villages and hamlets in India. Rural solar home systems and biomass gasification are two of India's most popular exports. At the end of September 2006, India had 1850 MW of minor hydroelectric power capacity constructed around the country. The rural use of solar PV has grown to include 340,000 residential lighting systems, 540,000 solar lanterns, and 7000 solar power water pumps. There are almost 600,000 solar cookers in use today. Rural (off-grid) electricity generation using small-scale biomass gasification systems is now possible in India. This is 70 megawatts (MW). Rural India's 70% of the population relies on biomass for 70% of their basic energy needs, which is a significant amount. The installation of about 100,000 biogas plants and 16,530 SPV lighting systems has resulted in the creation of numerous jobs and income-generating opportunities, particularly in the countryside. The development and

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desolation of 100 percent producer gas-operated engines was also carried out for rural electrification. Domestic, industrial, and commercial solar water heating systems have been erected in India, totaling more than 150,000 square metres. A million square metres have been added to the total area covered by the collectors that have been installed.

Table 3: Rural renewable energy's global standing

	1	2	3	4	5
Small Hydro, Wind, PV, Biomass	China	India	Nepal	Vietnam	Sri Lanka
Water Pumping, Mechanical Wind, PV	Argentina	China	South Africa	Namibia	India
Solar Home Systems	India	China	Thailand	Kenya	Sri Lanka
Biogas	China	India	Nepal		
Biomass Gasification	India	China			

V. RURAL RENEWABLE ENERGY IN INDIA'S FINANCING LANDSCAPE

In India, many products and systems that use renewable energy have been made, tested in the field, and used on a large scale for almost 40 years.

- In 1981, the Indian government established a Commission for Additional Sources of Energy (CASE), which was charged with developing policies and implementing them, as well as coordinating and enhancing research and development in the industry.
- When the Department of Non-Conventional Energy Sources was established in 1982, CASE was merged into the Ministry of Non-Conventional Energy Sources (MNES), which was renamed the Ministry of New and Renewable Energy (MNRE) in 2006. In the world, only India has a ministry dedicated solely to the development of clean, alternative energy sources. New and renewable energy sources are supported by MNRE in a variety of ways. Renewable energy sources like wind and solar power will be used to bring electricity to rural areas that don't get any of these types of power at the moment.
- According to the 9th, 10th, and 11th five-year plans, the main goals of the plan periods will be rural development and energy production. As part of its many technologies, the MNRE is also working on an integrated rural energy plan.
- Indian legislators introduced a new law in 2003, which is known as the Electricity Act. The Act is the most significant piece of legislation to have contributed to India's recent surge in the use of renewable energy sources. In addition to providing power to the utility grid, renewable energy technologies can be used in standalone systems.
- India's government, international funding sources, commercial banks and non-bank financial organizations, public stock markets, and the private sector all help pay for renewable energy in rural areas.
- Rural renewable energy development has been helped by cash grants, RESCOs, low-interest and long-term loans, joint ventures with businesses in other countries, subsidies, lower import duties for renewable technologies, and a lower Value Added Tax (VAT).

VI. ENVIRONMENTAL BENEFITS OF RENEWABLE ENERGY

Toxic air pollution, decaying biological systems, increasing climate change, and more are all a result of the existing energy use and economic growth patterns. Lack of access to energy services also leads to a variety of societal problems, such as poverty, illness, unemployment, and inequality. Indian oil consumption ranks fourth in the world, behind China, the United States, and Russia. The burning of fossil fuels for the production of heat, electricity, and transportation accounts for around 70% of

all global greenhouse-gas emissions. Energy conservation and efficiency improvements, improved energy management, cleaner production and consumption, and a shift in lifestyle are just a few of the solutions available for reducing greenhouse gas emissions. Climate change can be mitigated by the use of renewable and other more efficient technologies. Overall, countries may try to get people to make decisions based on science, which can lead to cleaner, more energy-efficient economic activity and better access to modern energy services.

In terms of long-term energy supply security, environmental advantages, and mitigating climate change, India places a high value on renewable energy development. The Integrated Energy Policy study has acknowledged the need to maximise domestic supply alternatives as well as to diversify energy sources. Reducing dependence on fossil fuels is a top priority for the committee.

VII. CONCLUSIONS

National energy policy is driven by three factors: energy security, economic growth, and environmental protection. Renewable energy sources can greatly alleviate concerns about the global energy problem by providing electricity and meeting other energy needs. The use of alternative fuels, especially biofuels, for blending with diesel and gasoline is expected to increase in the near future. Resolving barriers to the development and commercialization of renewable energy technologies such as biomass, hydroelectricity, solar, and wind technologies; promoting straight (direct) combustion and gasification of biomass and small wind electric generators; and improving the regulatory/tariff regime are some of the specific measures being taken to promote deployment, innovation, and basic research in renewable energy technologies. There are numerous advantages to using alternative sources of energy, such as wind and solar power, which can contribute significantly to the national energy mix, at least in terms of economic, environmental, and social costs. Using sustainable energy sources is especially important in rural areas, as this study explains. Once the country's energy requirements are met, its citizens' quality of life and the progress of the nation as a whole will improve.

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