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BENEFITS, RISKS AND TRADE-OFFS IN RENEWABLE AND LOW CARBON TECHNOLOGIES FOR GREEN ENERGY ELECTRICITYPRODUCTION IN INDIA

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Abstract

Global energy demand is expected to double by 2050, necessitating an estimated investment of 2.5 trillion USD per year in new energy installations and energy conservation initiatives over the next twenty years. Furthermore, rising energy demand and climate change efforts necessitate a significant increase in low-carbon electricity generation. However, there is concern that rapid investment in some novel technologies may result in a new set of environmental problems. When compared to coal, electricity generated by hydro, wind, solar, and geothermal power can reduce emissions of not only greenhouse gases (by more than 90%), but also pollutants hazardous to human health and ecosystems (by 60-90%). CO2 collection and storage from fossil fuel power plants will cut greenhouse gas emissions by 70% while increasing pollutants affecting human health and ecosystems by 5-80%. On the other side, there is a risk that the widespread adoption of low-carbon energy technology, while beneficial in lowering GHG emissions, will result in new environmental and societal consequences. India's installed power capacity is approximately 408.72 GW. India has achieved 166GW of renewable energy capacity. India has met its NDC target of 159.95 GW of non-fossil-based installed energy capacity, accounting for 41.4% of total installed electrical capacity. The major goal of adopting renewable and low-carbon green energy technology in India is to drive economic growth, improve energy security, increase energy access, and reduce climate change. This paper discusses the benefits, risks and trade-offs in renewable and low-carbon technologies for green energy electricity production in India. This study has adopted secondary research methods such as articles, journals, government reports, etc on renewable and low carbon energy. This study presents various investment benefits, employment opportunities and challenges in renewable and low carbon energy in India. Moreover, this study provides recommendations to foster the expansion of renewable and low-carbon technologies for green energy electricity production in India.

Keywords: *Renewable energy, Green energy, Low-carbon technologies, Challenges, Benefits.*

INTRODUCTION

Energy demand is expected to triple over the next few decades to meet the needs of a growing and developing world population. Indeed, more and more people are living longer and wealthier. To meet this demand, substantial financial investments in research, development and implementation of new power distribution systems will be required over the next 20 years. This is a problem, but it also presents opportunities to develop systems and use technologies that will reduce negative environmental, climate and human health impacts, as well as increased demands on natural resources.

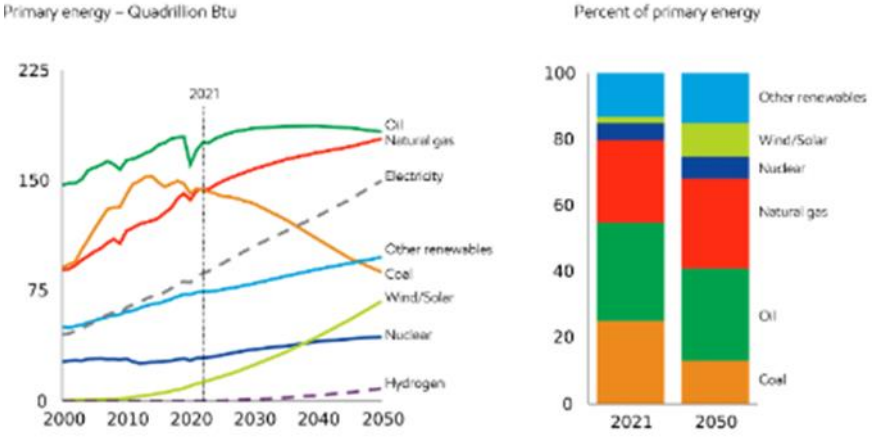

Figure 1: Global Energy Demand

In addition to its many negative impacts on human health and the environment, “electricity generation as an important energy carrier. energy with low CO2 emissions to meet the much lower requirements". Global warming target of 2 degrees set by the international community at the Paris climate conference. Combined with the impact of carbon prices and the expected rise in carbon prices, global energy demand will increase (Birol and Kant, 2022).

The emission reductions at other links in the economic chain may not address existing environmental or social concerns. Instead, new problems arise, such as heavy metal pollution, habitat destruction or pollution. 'resource depletion.However, it is also possible that this is not the case. The best course of action would be to reduce the impact of many problems while increasing the beneficial impact on energy consumption. Before investing trillions of dollars in the development and deployment of new energy technologies at scale, we need to understand the larger potential impacts of these technologies, both positive and negative. Only then can we make an informed decision on whether to pursue these initiatives. Assessing these impacts should be part of the “due diligence” required for such long-term investments.This will help prevent unintended impacts and will also help policy makers choose the cleanest, safest and most effective combination for a country, region or local community (Mareen, 2020).

India's growing demand for energy is a direct result of the country's efforts to achieve its stated goals for economic growth, which are currently being implemented. Producing ever more available energy is a necessary condition for a country's economic growth. The National Electricity Plan (NEP), formulated by the Ministry of Electricity (MoP), sets out a detailed 10-year plan of action to supply electricity to the nation. The plan is intended to be implemented over the next ten years.In addition, NEP has developed a strategy to ensure that the country's inhabitants can access electricity efficiently at an affordable price. The program is developed by NEP. You can find both programs here. According to a 2017 report by the World Resources Institute, India accounts for around 6.65% of global carbon emissions,” second only to China (26.83%), the United States of America (14.36%) and the European Union (9.66%). Climate change has the potential to upset the delicate ecological balance that exists on Earth. “Intended Nationally Determined Contributions have been subject to the United Nations Framework Convention on Climate Change (UNFCCC) and the Paris Agreement on Climate Change (INDC).One of the main objectives of the latter is to keep the rise in global temperatures well below 2 degrees Celsius.

Table 1: Installed power plant capacity in India (MW)

Region	Mode-wise breakup							Total
	Thermal				Nuclear	Hydro	Renewable	
	Coal	Lignite	Gas	Diesel				
Northern	49700.20	1580.00	5781.26	0	1620.00	19,707.77	13,994.37	92383.60
Western	70,328.62	1540.00	10,806.49	0	1840.00	7547.50	22,033.01	114,095.62
Southern	43,342.02	3240.00	6473.66	561.58	3320.00	11,774.83	36,389.87	105,101.96
Eastern	27,201.64	0	100.00	0	0	4942.12	1359.98	33,603.74
North-Eastern	520.02	0	1775.81	36.00	0	1427.00	291.87	4050.70
Islands	0	0	0	40.05	0	0	12.56	52.61
All India	191,092.50	6360.00	24,937.22	637.63	6780.00	45399.22	74,081.66	349,288.22

The World Energy Council predicts that 2030 will be the year when global electricity demand will peak. India is one of the largest coal consumers in the world, which forces the country to import the most expensive fossil fuel. Coal and oil together cover around 74% of the world's energy needs. India imported 171 million tons of coal in the 2013-2014 financial year, 215 million tons in the 2014-2015 financial year, 207 million tons in the 2015-2016 financial year and 195 million tons in fiscal year 2016-2017, according to a report by the Indian Economic Monitoring Center, in million tons in 2017. Fiscal year 2017-2018.

It examines gaps in supply, security, cost and renewable energy. Political stability and support for renewables can help. It focuses on access to energy markets, infrastructure and distributed generation, as well as financing, costs, availability and liquidity of transactions. The ranking reflects technological potential, "natural resources, energy production, potential support, projected support, technological maturity and expected expansion". India moves up two places to fourth place in RECAI-2018.India's installed solar capacity (including utility-scale solar and rooftop solar) increased from 4,313 MW in 2016 to 9,629 MW in 2017. Investors are concerned about solar tariffs. imports of solar energy and tensions between developers and distributors. Figure 6 shows the global installed capacity of renewable and low-carbon energy in 2016 and 2017.

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THE GLOBAL STATUS OF INDIA IN RENEWABLE AND LOW CARBON ENERGY

The global installed capacity of renewable and low-carbon energy was 2017 GW in 2016 and 2195 GW in 2017. The following table lists the cumulative new installed capacity of major countries up to 2017." "Fifth in renewable energy capacity (hydro), fourth in renewable energy capacity (without hydro), fourth in concentrated solar thermal (CSP) and wind power (Kumar and Majid, 2020)".

Table 2: National Renewable and Low Carbon Energies Attractiveness Index

Overall rank	Previous rank	Country	RECAI score	Technology-specific score (out of 100)							
				Onshore wind	Offshore wind	Solar PV	Solar CSP	Biomass	Geothermal	Hydro power	Marine
1	1	China	65.7	51	55	53	33	45	21	52	19
2	2	USA	63.8	50	53	49	32	39	39	35	31
3	4	India	63.8	50	20	57	34	44	25	45	21
4	3	Germany	62.7	46	50	49	17	44	34	35	20
5	6	France	62.5	50	51	48	22	48	33	31	36
6	5	Australia	62.3	47	30	54	35	24	21	39	31
7	8	Japan	59.2	43	44	47	18	51	48	36	23
8	7	UK	58.6	47	57	41	14	47	27	32	33
9	9	Netherlands	58.6	44	48	45	15	33	23	24	15
10	13	Argentina	58.6	45	21	50	30	37	32	37	20
11	11	Chile	56.7	43	20	47	32	37	31	41	28
12	15	Morocco	56.6	42	17	51	31	16	15	20	14
13	12	Mexico	56.3	43	19	50	25	45	43	34	19
14	10	Denmark	55.7	44	48	39	15	44	17	22	24
15	20	Egypt	54.9	45	14	52	36	13	12	27	12

INVESTMENT BENEFITS IN RENEWABLE AND LOW CARBON ENERGY IN INDIA

Income from renewable and low-carbon energy investments in India The amount invested in renewable and low-carbon energy in India in the first half of 2018 increased by 22% compared to the same period in 2017, while the amount invested in renewable and low-carbon energy has decreased in China over the same period by 15% (Jena et al., 2018). "India's investment in renewable and low-carbon energy grew by 22% in the first half of 2018, and India is expected to overtake China as the largest renewable energy growth market and low-carbon. Indeed, India's population is expected to continue to grow." .Another operator in California, Solar Star, increased its capacity to 579 MW in 2015. The Kamuthi solar power project in Tamil Nadu, India was the largest solar installation in the world in 2016 with a capacity of 648 MW ("set up in Tamil Nadu by Adani Green Energy, part of the Adani Group"). Longyangxia University, China The dam's solar park has a capacity of 850 MW and "surpassed all other solar installations to become the most powerful in the world" since February 2017. There are currently 600 MW units in operation and 1400 MW units in development course.

Figure 2: Shakti Sthala Solar Park

On March 1, 2018, Shakti Sthala Solar Park opened in Pawagada, Karnataka, India.Once it reaches its full capacity of 2 gigawatts (GW), it is expected to be the largest solar farm on the planet. Another huge solar park is proposed to be developed in the Kadappa region, this one with a capacity of 1.5 gigawatts (GW). The significant advances in solar power demonstrate a real boom in renewables (Dawn et al., 2019).

Figure 3: Kurnool Mega Solar Park.

The Kurnool Mega Solar Park produced 800 million mega-units (MU) of electricity in October 2018 and avoided more than 700,000 tonnes of CO2 emissions.Using tanks that also collect rainwater for harvesting is an effective way to keep solar panels clean and ensure they have a constant water supply. The United States has made no small progress in solar energy, thanks to its efforts.

Figure 4: Kamuthi Solar Farm

The Kamuthi Solar Farm is regularly maintained by a robotic system responsible for this task. India's annual energy consumption is expected to reach 15,280 TWh by 2040 due to GDP growth. This figure was calculated using current technology.The goal of green energy, also known as the renewable energy sector, is central to the government's efforts to ensure substantial expansion in a way that attracts domestic and foreign investors. Investments are expected to yield up to $80 billion over the next four years. The target capacity for renewable and low carbon energy in India has been increased from 175 GW to 225 GW by 2022 due to the Indian government's decision to increase its target from 175 GW previously. The country also has significant untapped hydroelectric potential, another factor contributing to the country's competitive advantage (Dawn et al., 2019)". 2019 are "3.01GW, 5.52GW, 9.36GW and 6.53GW. In the next two years of 2019, the country will strive to build eight.5 GW capacity. The country is one of the main beneficiaries of solar energy due to its privileged location in the solar belt which extends from 400 degrees south latitude to 400 degrees north latitude, and has a fairly large availability of due to its location at 400 degrees north latitude.

The country is one of the main recipients of solar energy" and has sufficient availability due to its location. The solar belt extends from south 400 to north 400. The installed solar capacity is expected to reach 100 GW by 2022, and this increase is "Over current levels, 25.21226 GW in December 2018. This is a forecast based on the fact that installed wind capacity is currently lower than solar , which is expected to reach 100 GW by 2022.Solar photovoltaic (PV) has become the industry with the greatest potential for new financial investment due to the sharp decline in prices. As part of the 2018-2019 Union budget, a 0% import duty on components used to manufacture solar panels was introduced to give domestic solar panel manufacturers a competitive advantage (PIB, 2018). This is done to give domestic solar panel manufacturers an edge in the market. An assessment by the Department of Industrial Strategy and Development (DIPP) estimated that foreign direct investment (FDI) inflows into India's renewable and low-carbon energy sector during the period from April 2000 to June 2018 was $6.84 billion.According to a government announcement dated January 27, 2019, the Department of Industry and Domestic Trade Promotion (DIPP) is now renamed the Ministry of Industry and Domestic Trade Promotion. He is responsible for the expansion of domestic and retail trade, as well as the well-being of traders and the employees who work for them, as well as matters related to the promotion and assistance of business operations for the start-up of new businesses. and continuation of existing businesses. Since 2014, investments totaling over $42 billion have been invested in "Renewable Energy India". India received $7.4 billion in investments in the first half of 2018.Between April 2015 and June 2018, the country received a total of $3.2 billion in the form of foreign direct investment (FDI) in the renewable energy sector. Annualized cash inflows increased from $776 million in fiscal year 2015-16 to $783 million in fiscal year 2016-17 and then to $1,204 million in fiscal year 2017 -2018. From January to March 2018, foreign direct investment of INR 4.52 billion or USD 63.3389 million was made.As part of its contribution, the country offers a number of "fiscal and promotional incentives, including capital grants, accelerated depreciation (AD), waiver of interstate transmission costs and losses, funding for viability gap (VGF) and foreign direct investment (FDI) 100% lower than the automated route. These are just some of the financial and promotional incentives offered (Kumar and Majid, 2020).

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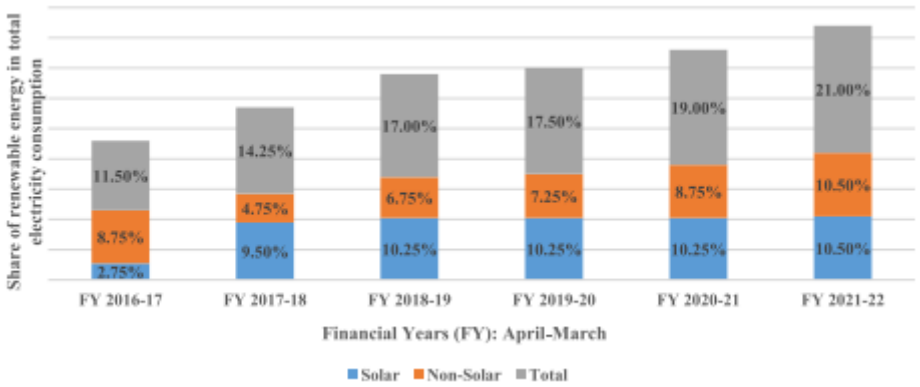

Figure 5: Target Share of Renewable Energy in India's Power Consumption

EMPLOYMENT OPPORTUNITIES IN RENEWABLE AND LOW CARBON ENERGY IN INDIA

Jobs in the renewable energy sector can be grouped into the following four categories: development of new technologies; installation of new systems; operation and maintenance of existing systems; and decommissioning of existing systems. existing systems Due to the rapid development of technology, employees in every department must keep their skills up to date."This can be achieved through participation in continuing education or on-the-job training, and in some cases, employees can benefit from professional certification. carbon emissions, jobs have the potential to revolutionize rural economies (Benedek et al. People, 2018) The renewable and low-carbon energy industry has the potential to contribute to poverty reduction by increasing the number of jobs available. For example, "The wind energy industry seeks qualified professionals with experience in a wide range of fields, including manufacturing, project development, construction and installation of turbines, as well as as financial services, transportation and logistics, and operation and maintenance. " According to the NDRC (2022), the main employment outcomes in renewable energy and low-carbon energy are as follows: • The vast majority of the workforce in the renewable energy sector is under contract and employees in this sector do not have permanent employment or work-related benefits.• Consistent employment in the same job can mitigate some of the worst effects of poverty. • The vast majority of low-income residents find it difficult to access basic skills programs and enter the labor market because they do not have enough information about the types of jobs available and their qualifications required. • There are not many programs promoting public ownership opportunities and women's participation in the renewable energy industry.

CHALLENGES OF RENEWABLE AND LOW CARBON ENERGY IN INDIA

Policy and Regulatory Barriers:

There is no well-established policy statement and regulatory framework in place for renewable energy."When it is necessary to stimulate the development of specific renewable energy and low-carbon energy technologies, policies that do not comply with the renewable energy and low-carbon energy development plan may be announced. Indeed, renewable energy and low carbon energy carbon energy - carbon energy carbon energy Technology is constantly evolving." • Because each state is responsible for determining its own RPO (Renewable Power Purchase Obligation), each state has a different regulatory structure and process. This leads to a higher investment risk in this market.

Institutional obstacles:

Lack of inter-agency coordination between the various institutes, agencies and stakeholders working within the MNRE.The development of low-carbon and renewable energy is held back by lack of cooperation and coordination and delays, which in turn limit the progress that can be made. Investors are losing interest in the market due to delays caused by the government's inability to properly coordinate policy implementation (Goldensach, 2017).

"The Single Window Project Approval and Approval System is inefficient and unstable as it causes delays in project approvals and ultimately leads to fines being imposed on project proponents".

Financial and Fiscal Barriers:

"A number of budgetary constraints need to be overcome to meet the demands of developing the renewable energy sector. These constraints include funding allocations and budgets not being delivered on time.These budgets are problematic because they inhibit the growth of the renewable energy sector (Lai et al., 2016)".

The initial unit investment cost of renewable energy projects is much higher than that of fossil fuels, which leading to funding and investment challenges Higher initial load
Potentially unpredictable resource assessments, unawareness of technological improvements and awareness of high risks, all of which lead to financial hurdles for product manufacturers (World Economic Forum, 2016)

Market Barriers:
Conventional fossil fuels are sufficiently subsidized, creating the false "perception that electricity generated from conventional fuels has a higher priority than electricity from renewable sources (subsidy structure unfair)" "There is a 'supply-demand' imbalance in the biomass market which has led to a sustained increase in biomass prices. This trend should continue.This is the direct result of an inconsistent supply of biomass (and the absence of an organized market for fuels), which in turn leads to significant price variations. Moreover, there is no centralized market for the sale of gasoline. Due to the different types of biomass used in Indian states, there are considerable fluctuations in the supply and demand of biomass.
Wind, solar, and solar thermal plants cannot be built due to insufficient land volumes, resulting in insufficient capacity additions in many states. "

Technical Barriers:
Every installation of a renewable energy project introduces complex risk issues that can develop due to the possibility of unfamiliar environments, natural disasters, improper planning, power failures, equipment and financial losses.
Few R&D centers focus on alternative energies. Measures to cut government subsidies and increase R&D spending have taken longer than expected, while industrial facilities are essentially replicating technologies already in use. The availability of machinery and the latest technology in this country is entirely dependent on suppliers located in other countries. The fact that the parts are not made in the region is a key factor in their lack of availability.

Barriers to awareness, education and training:
Lack of human resources with the necessary training and expertise in the field of renewable and low-carbon energy.This shortage is due to the growing demand for this source of energy. Moreover, it faces a severe shortage of readily available manpower.
The general public cannot participate in any awareness-raising activities and therefore has insufficient knowledge of renewable energies. Lack of understanding of the technology is a significant barrier to purchasing large tracts of land for renewable energy power plants. Since agriculture is the main source of income for most Indian citizens, landowners who grow plants on their land are opposed to selling the plants in order to build power plants there.

RECOMMENDATIONS

- To promote the development of the renewable energy industry, the Ministry of New and Renewable Energy should include a comprehensive action plan or strategy in its regulatory framework for the renewable energy industry. Once the action plan is developed in cooperation with the National Electricity Regulatory Commission, it will be possible to implement the policy/action plan within a certain timeframe.
- Substantial government financial support must be provided to the renewable energy industry. China spends 128 times more than India each year on renewable energy R&D. This compares to India's spending in 2017, which was $10.9 billion, China's expenditure in 2017 was US$126.6 billion, equivalent to 9 trillion Indian rupees (755 billion rupees). Although budget allocations for grid-connected wind and solar increased in 2018, these amounts are still insufficient to meet renewable energy targets.
- The state must refocus its industrial efforts on business taking place within its borders. Since 90% of the solar cells and modules it uses are imported from Malaysia, China and Taiwan, there is a strong need for a reliable domestic manufacturing infrastructure.
- Governments should promote partnerships between the private sector and educational institutions to foster innovative forms of research and development and support innovative strategies to develop clean energy for the benefit of environmental protection. future generations.

CONCLUSION

The growing world population has growing energy needs which require significant financial investments. This presents an excellent opportunity to make technical decisions that take into account and, where possible, "minimize the negative impacts on the environment, ecosystems and human health. If it were possible to mitigate many of the negative impacts on the environment, if the project is correctly selected, designed and executed as well as its design and operation.The relatively small increase in iron and cement consumption associated with low-carbon technologies is not a major challenge, as iron and cement are abundant and only a small fraction of total demand is used

in systems. electrical connected. major question. The use of copper and other functionally important metals may pose certain long-term challenges, based on substitution opportunities that are not yet fully realized. These challenges may arise because the potential for substitution has not yet been fully realized. The Indian government should make a statement on developing a sound financial aid strategy.The program may involve extending credit, reducing loan amounts and interest rates. To ensure that all power DISCOM PPAs cover 100% of their RPO commitments, the government should amend existing legislation to make the requirements set out in power purchase agreements (PPAs) legally enforceable. This will enable the government to achieve its objective of ensuring that all power DISCOM PPAs cover 100% of their RPO commitments. It is strongly recommended to use conventional energy sources and storage devices with renewable energy sources, using a hybrid design of two or more resources to achieve the goal of developing reliable systems. This can be achieved by creating a hybrid design with two or more resources.In the case of hybrid systems, the development of the necessary regulations and standards falls under the purview of different regulatory bodies. By implementing effective policies and providing tax incentives, creating the conditions under which investments can be made economically will bring social benefits beyond economic ones. This is so because creating these conditions will lead to creating the conditions under which investments can be made economically.

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