BARRIERS TO RENEWABLE ENERGY IN INDIA

Mr. Himanshu Shukla[1*], Sabiha Parwin[2], Jessamin Yadav[3], Himanshi[4], Akshat[5], Aman kumar Gupta[6], Cristeta Esperanza Nfono Oyegue Sabana[7]

Article History: Received: 22.02.2023 **Revised:** 07.04.2023 **Accepted:** 22.05.2023

Abstract

Renewable energy has dominated scientific research since the dawn of the twenty-first century. Though scientists have developed convincing and useful renewable energy solutions, especially in impoverished countries, the process of persuading people to stop using non-renewable energy sources has been quite sluggish and unsure. This essay seeks to understand the reasons why many nations continue to rely on fossil fuels, particularly coal, and the difficulties in implementing renewable energy technologies, which harm the potential of those technologies in many nations.
The over-reliance on fossil fuels (coal), political and regulatory obstacles, technical obstacles, market related obstacles, social and cultural obstacles, financial and economic obstacles, and geographic and ecological obstacles have all been discussed in the essay as barriers to the adoption of renewable energy. The paper identifies gaps in renewable energy development that researchers, students, policymakers, and individuals or organizations who may be concerned with promoting renewable energy technologies may need to address in their research and decision-making processes.

[2]B.COM(H), Student, GD Goenka University, India.
[3]B.COM(H), Student, GD Goenka University, India.
[4]B.A.L.L.B, Student, GD Goenka University, India.
[5]B.Com L.L.B, Student, GD Goenka University, India.
[6]BCA, Student, GD Goenka University, India.
[7]Student, GD Goenka University, India.

DOI: 10.31838/ecb/2023.12.s3.377

Corresponding Author: Mr. Himanshu Shukla[1*]
[1*]Assistant Professor, School of Law, GD Goenka University, India.

1. Introduction

Energy use is required for physical and socioeconomic growth in both rural and urban environments. Fossil fuels are the dominant source of energy in the world's energy mix, but they are also the main cause of the high levels of carbon dioxide emissions in the atmosphere, leading to an acceleration of global warming. So, one of the key elements in the disparity between industrialized and developing nations is access to renewable energy. Due to the increased reliance on conventional energy sources like fossil fuels (coal, gas, oil, and radioactive ore) around the world and the resulting environmental effects, efforts have been made to lessen reliance on these resources by increasing the supply of renewable energy, but to date, there hasn't been much of an impact.
Most nations have a significant potential for producing renewable energy, according to numerous research. But compared to their potential, these nations' current use of renewable energy is insignificant for a variety of reasons. For instance, despite having a wealth of both conventional and renewable energy resources, coal has remained the country's main source of electricity because it is readily available, meets demand, and is relatively inexpensive.
Similar to other developing regions, Africa has limited access to renewable energy because of poor energy policy, inadequate funding, outdated technology, and inadequate infrastructure. As a result of the rising energy crisis brought on by the developing countries' rapid population expansion and accompanying rise in energy consumption, people's reliance on non-renewable energy sources has increased.

Different Sources Of Renewable Energy In India

Solar Energy

The most plentiful source of energy is solar energy, which may even be used under cloudy conditions. The rate at which the Earth absorbs solar energy is around 10,000 times higher than the rate at which people use energy. For a wide range of applications, solar systems can provide heat, cooling, natural lighting, power, and fuels. Solar technologies can use photovoltaic panels or solar radiation-concentrating mirrors to turn sunlight into electrical energy. Although not all nations have the same access to solar energy, direct solar energy can nevertheless make a major contribution to any nation's energy mix. India's solar power business is expanding quickly. As of March 31, 2023, the nation had 66.78 GWAC of installed solar power, it's use of solar energy will place fourth worldwide in 2021.

India intends to publish 40 GW of solar and hybrid project tenders in FY 2023–2024. To make land available to those who are promoting solar plants, India has developed roughly 42 solar parks, nearly 20.7 billion US dollars in foreign money was invested in solar power projects between 2010 and 2019.

India proposed the creation of the International Solar Alliance (ISA), which has its headquarters there. The "World Solar Bank" and "One Sun One World One Grid" concepts have also been proposed by India as ways to harness the plentiful solar energy on a global scale.

Wind Energy

Large wind turbines placed on land (onshore) or in saltwater or freshwater (offshore) are used to capture the kinetic energy of moving air. Although wind energy has been used for thousands of years, onshore and offshore wind energy technology has advanced recently to maximize the amount of electricity produced, using higher turbines and bigger rotor diameters.

Even though average wind speeds vary greatly from place to place, most locations of the world have the potential for considerable wind energy deployment. In fact, the technical potential for wind energy is more than global power production. Strong winds can be found in many locations around the world, but often distant areas are the greatest for producing wind energy. Offshore wind energy has a lot of potential.

In India, wind power generated 71.814 TWh, or roughly 4.43% of all electricity generated, in the fiscal year 2022–23, which is almost 10% of the country's total installed utility power production capacity. In the fiscal year 2022–2023, the capacity utilization factor is close to 18% (19.33% in 2018–19, 16% in 2017–18, 19.62% in 2016–17, and 14% in 2015–16). The five-month period from May to September, which coincides with the duration of the Southwest monsoon, is when 70% of the yearly wind energy is produced. Since solar energy is produced primarily during the daytime, non-monsoon season in India, it is a useful complement to wind energy. Since about 60% of wind energy is produced at night, it is priced similarly to solar energy that has been stored.

Geothermal Energy

Geothermal energy makes use of the thermal energy that is available from the Earth's interior. Geothermal reservoirs can be heated using wells or other methods. Hydrothermal reservoirs are those that are naturally sufficiently hot and permeable, whereas enhanced geothermal systems are those that are naturally adequately hot but improved by hydraulic stimulation.

Different temperature fluids can be used to produce electricity once they reach the surface. Since it has been in use for more than a century, the technology for producing energy from hydrothermal reservoirs is established, dependable, and mature.

In India, geothermal field research and exploration first started in 1970. The Geological Survey of India has identified about 350 geothermal energy locations in India. The most promising of these is the Puga valley in Ladakh. India's geothermal regions include the Himalayas, Sohana, West Coast, Cambay (Gujarat), Godavari, Mahanadi, and Son-Narmada-Tapi (SONATA), in addition to a variety of geothermal springs. There may be a 10 gigawatt (GW) geothermal power potential in India, according to the Ministry of New and Renewable Energy, whose geothermal resources have been mapped. The first geothermal power plant in the nation will be built by the Chhattisgarh government in Tattapani in the Balrampur district.

Hydropower

The energy of water flowing from higher elevations to lower elevations is captured by hydropower. It can be produced by rivers and reservoirs. Run-of-river hydropower facilities rely on the river's available flow, whereas reservoir hydropower plants use water that has been stored in a reservoir.

In addition to supplying energy, hydropower reservoirs frequently serve as sources of drinking water, irrigation water, flood and drought control, navigation services, and energy.

The largest renewable energy source in the electricity sector at the moment is hydropower. It depends on relatively consistent rainfall patterns, which can be adversely affected by droughts brought on by climate change or by changes to ecosystems that affect rainfall patterns.
In terms of hydroelectric power capacity installed, India is fifth in the world. India had a utility-scale hydroelectric capacity of 46,000 MW installed as of March 31, 2020, or 12.3% of its total utility power production capacity. Additional smaller hydroelectric generating units have been erected, totalling 4,683 MW, or 1.3% of the country's potential for utility power generation. At a 60% load factor, India's hydroelectric power potential is calculated to be 148,700 MW.

Bioenergy
Bioenergy is made from various organic resources, known as biomass, including wood, charcoal, dung, and other manures to produce heat and power, as well as agricultural crops for the creation of liquid biofuels. The majority of biomass is utilized by impoverished populations in developing nations in rural regions for cooking, lighting, and space heating.
Dedicated plants or trees, agricultural and forestry waste products, and diverse organic waste streams are all used in modern biomass systems. When biomass is used for energy, greenhouse gas emissions are produced, although at a lesser rate than when fossil fuels like coal, oil, or gas are burned. However, given potential adverse environmental effects connected to significant expansions in forest and bioenergy plantations, and the ensuing deforestation and land-use change, bioenergy should only be employed in limited applications.
Based on the entire installed capacity of bioenergy plants in India as of August 2022, the economy had generated an estimated 0.43 million direct jobs and 0.66 million indirect jobs. Around 0.25 million of these positions, which span the entire value chain of bioenergy initiatives, are for women. India generates between 450 and 500 million tons of biomass annually. Currently, 32% of the primary energy used in the nation comes from biomass.

Barriers To Renewable Energy

1. Regulatory barriers:
There are a few regulatory barriers that limit the advancement of renewable energy for electricity generation, thermal use purposes, space and water heating and cooling, and transportation. Lack of national regulations, administrative and bureaucratic obstacles, insufficient financial incentives, unrealistic government goals, and a lack of standards and certifications have all impeded the rapid expansion of renewable energy.

(a) Lack of policies and regulations: The lack of clarity in the guidelines about how to achieve the agenda set in the Paris Agreement. This results in a lack of confidence. In the absence of established standards for solar panel quality, efficiency, and durability, subpar equipment may be utilized in solar installations. All this generates uncertainty for developers and investors. Policy and regulatory inconsistency can impede the expansion of renewable energy installations.
(b) Permits and approvals: There are bureaucratic barriers to getting licenses and permits, or ambiguous instructions for connecting to the grid. It can be a drawn-out and challenging procedure to obtain the licenses and permits that renewable energy projects need from numerous regulatory organizations. The execution of a project can be delayed by delays in obtaining licenses and permissions.
(c) Lack of enforcement: What the law requires and what is actually executed frequently differ. The reason for such a reality is mostly corruption and political influence. It's possible that regulatory bodies lack the personnel and technology required to successfully implement rules and regulations. Inspections and compliance checks may be delayed as a result, making it simpler for violators to continue operating undetected.
(d) Unrealistic government commitments: Regulations that are impractical or unrealistic might put needless barriers in the way of investors and developers, making it difficult to execute renewable energy projects. Lack of vision of a practical goal and flaws in the implementation procedure itself. Regulations that impose unreasonably strict time constraints on project development and execution might act as a roadblock for renewable energy initiatives. For instance, it can be difficult for developers and investors to complete a renewable energy project if a legislation calls for it to be finished in a limited amount of time.
(e) Inadequate distributed generation compensation: Small-scale renewable energy technologies known as distributed generation produce power at or close to the area where it will be used, such as solar panels on rooftops. Investors in renewable energy systems may find it financially impossible to do so if the remuneration for distributed generation is insufficient. The overall expansion of renewable energy in India may be hampered by this restriction on the number of renewable energy systems that are installed and deployed.

2. Financial barriers:
Deploying renewable energy in India may also be severely constrained by financial barriers. Here are a few instances of financial barriers that hamper the development of renewable energy in the nation.

a) High cost of capital- Installing solar panels and other equipment requires a substantial initial expenditure, which many families and small companies cannot afford. Even if the cost of solar panels has fallen recently, the initial investment is still a major roadblock.
b) Uncertainty about return on investment: Because investors are doubtful of the returns on their investment, they are reluctant to invest in renewable energy. They might lack confidence in their ability to sell extra energy back to the grid at a fair price or in the ability of the solar panels to produce enough energy to fulfil their demands.
c) High Payback period: The term "payback period" describes how long it takes for the investment in a renewable energy system to pay for itself by reducing energy expenditures. The payback period tends to be quite long in the case of such investments which makes it harder for investors to justify such investment. The cost of energy has a direct impact on how quickly renewable energy systems pay for themselves. A renewable energy system may take longer to pay for itself if energy costs stay low, lengthening the payback time. Technical restrictions in some situations can also make it take longer for renewable energy systems to pay for themselves.
d) Intangible costs: Intangible costs are difficult to quantify in monetary terms, so they affect the overall cost-benefit analysis of renewable energy projects.
e) Debt-equity ratio: When determining whether a project is financially feasible, the debt-to-equity ratio may be a crucial element to take into account. The initial costs associated with renewable energy projects are often high, and the project's long-term financial success can be significantly impacted by its financing arrangement. If lenders believe a renewable energy project has a high financial risk, a high debt-equity ratio may make it more difficult for the project to obtain finance. A low debt-to-equity ratio, on the other hand, may make it simpler for a renewable energy project to get funding because it denotes a lower amount of financial risk.

3. **Economic barriers**:
Economic barriers to renewable energy can be the lack of education and knowledge among the public about the advantages of renewable energy, as well as government policies and laws that favor conventional energy sources like fossil fuels over renewable energy.

(a) Cost competitiveness: Solar panels and wind turbines are still somewhat expensive when compared to traditional fossil fuel-based energy systems, despite significant declines in cost. Due to this, it may be challenging for people, organizations, and governments to invest in renewable energy systems, especially in developing nations where available resources may be scarce.
(b) Limited market size: Energy production costs can be reduced via economies of scale, making renewable energy more affordable than conventional energy sources. The market size for renewable energy technology is closely related to economies of scale in the field. Larger markets often provide longer production runs, which can aid in reducing per-unit production costs and improving supply chain and logistics efficiency. Economies of scale are projected to grow as the market for renewable energy technology expands, lowering costs and promoting wider adoption. But not all markets for renewable energy will inevitably benefit from economies of scale. Rooftop solar panels and other distributed generation systems could fail to benefit from the same economies of scale as large-scale renewable energy installations.
(c) Infrastructure: Another hurdle is the price of incorporating renewable energy into the current electricity infrastructure. Since intermittent renewable energy sources like solar and wind can be difficult for grid operators to manage, dependable and steady power supply typically necessitates extra infrastructure and energy storage technologies. This can significantly increase the cost of renewable energy projects and reduce their economic viability.
(d) Dependence on subsidies and grants: If subsidies and grants are not sustainable or are subject to changes in government goals or policies, they also act as an economic obstacle. Dependence on grants and subsidies may make it less likely for the private sector to engage in renewable energy and may take money away from other crucial sectors like grid infrastructure and energy storage.
(e) Lack of financial institutions to support REPs: Due to perceived risks including uncertainties surrounding energy production and return on investment, many financial institutions are reluctant to engage in renewable energy projects. As a result, there may be fewer financing choices available for renewable energy projects, which can make it more difficult for project developers to acquire the funds they need to see their plans through to completion.

4. Technical barriers:
Technical barriers can raise the costs of project development and undermine investor trust in the adoption of renewable energy. Additionally, it may result in a market that is fragmented and has various standards for quality and safety, making it challenging for customers to compare and select products.

(a) Lack of standard and codes and certification: Codes and standards serve as a foundation for regulatory compliance and quality control and are crucial for guaranteeing the performance, dependability, and safety of renewable energy systems. Comprehensive rules and standards for renewable energy systems are lacking in India, especially for more recent innovations like energy storage and microgrids. This makes it challenging to guarantee the security and dependability of renewable energy systems and might result in uncertainty and inconsistent project development. For assuring the dependability and quality of renewable energy technology, certification programmes are also crucial. Particularly for smaller-scale systems like rooftop solar panels, India lacks nationally recognized certification programmes for renewable energy goods.
(b) Grid integration issues: Because they are erratic in nature, renewable energy sources like sun and wind can be difficult to integrate. The intermittent nature of these sources can cause grid instability and make it challenging to maintain a balance between supply and demand for electricity. Grid infrastructure must be updated, and new technologies like energy storage and smart grid systems must be implemented, in order to get beyond this obstacle.
(c) Lack of skilled personnel/training facilities: India's renewable energy industry is still developing, and both technological know-how and skilled labor are in short supply. Delays in project development and higher expenditure may result from this. Greater investment is required in education and training programmes to create the essential skills and expertise in order to overcome this hurdle. Rooftop solar panels and other distributed generation systems might not experience the same economies of scale as large-scale renewable energy installations.
(d) Lack of O&M facilities: In India, there is an absence of qualified O&M specialists and an absence of O&M services. Lack of Operation & maintenance facilities may result in more system downtime and poorer system performance, which may reduce energy production and raise operating expenses. Additionally, it may result in a lack of confidence and trust in renewable energy systems, which may discourage investment and hinder the uptake of renewable energy.
(e) System constraints: India's energy grid was initially built to support a centralized power generation system, which is typified by big coal- or gas-fired power stations that send electricity over extensive transmission lines to remote areas. It can be difficult to integrate renewable energy sources like solar and wind into the electricity system because of their sporadic nature. Since renewable energy sources are frequently found in isolated locations, it can be challenging to distribute power to those locations. Furthermore, because renewable energy production is unpredictable, the power system may become unbalanced, which could compromise the grid's dependability and stability.

Ways to overcome the barriers
1. Regulatory barriers
- Improving the predictability of policy, cutting bureaucratic red tape, and streamlining regulatory procedures can all assist to lower risk and boost investor confidence.
- Increased financial incentives can help offset the upfront costs of adoption by making renewable energy projects more financially appealing. Financial incentives include tax exemptions and subsidies.
- Feed-in tariffs offer a fixed price for the production of renewable energy and can aid in generating a steadier and more predictable stream of income for renewable energy projects.
- Creating thorough codes and standards for renewable energy systems can aid in ensuring their performance, dependability, and safety as well as making it simpler for regulators to assess project proposals.
- Public-private collaborations can help to combine the knowledge and resources of the public and private sectors, allowing for the creation of creative business and financing models for renewable energy projects.

2. Financial barriers
- Increasing access to capital can help to lessen the financial burden on project developers and enhance investment in renewable energy projects by opening up funds through public and private financing sources.
- Setting up a Renewable Energy Fund might aid in financing renewable energy initiatives, particularly smaller-scale initiatives that might find it challenging to obtain conventional financial sources.
- Expanding investment opportunities and facilitating the development of new finance models for renewable energy projects can be accomplished through peer-to-peer lending and crowdfunding.

- Public-private partnerships can aid in the leveraging of the skills and resources of both the public and private sectors, as well as the facilitation of the creation of novel business and financing models for renewable energy projects.

3. Economic barriers

- Investment in renewable energy projects can be increased by encouraging private sector investment through tax incentives, subsidies, and other financial instruments.
- Implement power purchase agreements: Power purchase agreements (PPAs) can give renewable energy projects a steady and predictable cash stream, lowering risk for investors and increasing their appeal for finance.
- Creating innovative business models, including locally owned renewable energy projects, can aid in finance access and local economic development.
- Encouragement of energy-saving measures, such as building retrofits and smart grid technology, can help to lower energy consumption and improve the financial viability of renewable energy sources.
- General energy demand can be decreased by spreading awareness of the advantages of renewable energy and encouraging the use of energy-saving practices.

4. Technical barriers

- To ensure that renewable energy systems are secure, dependable, and effective as well as to inspire investor trust, technical standards and certification procedures can be developed.
- Engineers, technicians, and other professionals can benefit from training and capacity-building programs that are designed to advance best practices for the implementation of renewable energy.
- Implement quality assurance procedures to ensure that renewable energy systems are working as efficiently as possible and lower the possibility of equipment failure by putting quality control measures in place, such as routine inspections and maintenance.
- Investments in grid infrastructure, such as smart grid technology and energy storage systems, can assist in addressing the erratic nature of renewable energy sources and ensuring their successful integration into the electrical grid.
- Promoting best practices and identifying technological solutions to common problems can be accomplished through encouraging cooperation and information exchange among stakeholders in renewable energy, including business organizations, researchers, and legislators.

2. Literature Review

1. SWOT analysis: A framework for comprehensive evaluation of drivers and barriers for renewable energy development in significant countries
   Author- Rajvikram Madurai Elavarasan, Syed Afridhis, Raghavendra Rajan Vijayaraghavan, Umashankar Subramaniam, Mohammad Nurunnabi
   The scope of the study is to examine the factors that motivate and discourage the growth of renewable energy in the studied nations, which also include China, India, Iceland, Sweden, and the US. Each of these nations has particular strengths in the origin of renewable energy. By using a SWOT analysis, where each country will be evaluated based on the four factors Strength, Weakness, Opportunities, and Threats for renewable resources, this work provides a descriptive picture of the nation's renewable assets and its green future.
2. A collection of SWOT factors (strength, weaknesses, opportunities and threats) for hybrid energy networks
   Author- Ralf-Roman Schmidt, Benedikt Leitner
   This study provides the first insights on potential advantages, disadvantages, chances, and risks for hybrid energy networks. A bigger target group is being examined for the qualitative SWOT analysis planned for stage three, which may include a variety of policymakers, energy providers, network operators, and transmission and distribution system operators from IEA DHC member nations. The IEA DHC Annex TS3 "Hybrid Energy Networks" international cooperation programme served as the inspiration for the creation of this report.
3. Status of solar wind renewable energy in India
   Author- Vikas Khare, Savita Nema, Prashant Baredar
   This paper studied both actual and provisional scenarios for renewable energy in India. The discussion shows that condition of renewable energy sources such as solar and wind system is satisfactory in India but requires additional attention for better development of renewable energy sources. Renewable energy systems continue to be expensive sources of energy, despite recent progress in cost reduction and technology advancement.

4. A Comprehensive Review on Renewable Energy Development, Challenges, and Policies of Leading Indian States with an International Perspective
   Author- Rajvikram Madurai Elavarasan, GM Shafiallah, Sanjeevikumar Padmanaban
   This study examined the nation's numerous renewable energy prospects with the intention of assisting academics, researchers, and policymakers by providing information on the nation's current renewable energy landscape. The three Indian states of Karnataka, Gujarat, and Tamil Nadu, which are pioneers in the production of renewable energy in India, are extensively discussed in the review paper. With an emphasis on India, the global energy landscape was thoroughly examined.
5. Indian wind energy & its development-policies-barriers: An overview
   Author- Shubham Sharma, Sunanda Sinha
   The findings of this study support the efforts done by the Indian government (both Central and State) in the field of wind energy, showing decreased costs for renewable energy sources, better financial incentives, prospects for offshore wind energy, and stable market growth. It also offers a thorough analysis of the financial incentives and development programmes the Indian government has made available to boost the country's wind energy industry. India's wind energy policies have been carefully examined and the challenges that these policies and projects face.
6. A comprehensive analysis of strategies, policies and development of hydropower in India: Special emphasis on small hydro power
   Author- Naveen Kumar Sharma, Prashant Kumar Tiwari, Yog Raj Sood
   The analysis of the current situation, potential plans, and current and future policies pertaining to the development of hydropower in India, with a focus on SHP, has been the main goal of this research. It comes to the conclusion that SHP development is crucial for long-term energy supply security, decentralisation of energy delivery, especially for the benefit of rural populations, and environmental and power sector sustainability.
7. Geothermal energy provinces in India: A renewable heritage
   Author- Kriti Yadav, Anirbid Sircar
   In terms of temperature and geochemistry, this study describes and models all of the significant geothermal fields. Numerous workers conduct geological, geophysical, and hydrological studies in practically all sectors. The usage of geo-thermal water locally and its local development in various Indian locations are discussed in the article. Additionally, it describes how geothermal water might be employed for societal advancement in balneology, power production, space cooling and heating, crop drying, honey production, etc.
8. Breaking barriers in deployment of renewable energy
   Author- Seetharaman, Krishna Moorthy, Nitin Patwa, Saravanan, Yash Gupta
   This study explains how the deployment of renewable energy is strongly influenced by social and technological regulatory hurdles, while economic constraints have a large indirect impact. Organisations can invest heavily in creating cutting-edge technology that can maximise the use of renewable energy and make it appear more profitable than other sources of energy by overcoming constraints connected to research and development.
9. Incentives and strategies for financing the renewable energy transition: A review
   Author- Sikandar Abdul Qadir, Hessah Al-Motairi, Furqan Tahir, Luluwah Al-Fagih
   In this paper, we get to know how the global population set to continue growing, the demand for energy will increase. Fossil fuel resources are on the decline, their use is associated with environmental disruption. It highlights the need for more investment in energy resources that can meet the global demand while not harming the environment. Clean forms of energy, such as solar, wind, and hydropower, are both successful and readily available as well, yet investment in them has fluctuated for some reason apparently. The affordability or in other words the feasibility and technological maturity of oil in some regions has contributed to the slow uptake of investment in renewable energy projects.
10. Barriers in the Advancement of Solar Energy in Developing Countries like India
    Author- Suprava Chakraborty, Pradip Kumar Sadhu, Utpal Goswami
    This paper tells us about the current energy market scenario and different types of barriers related with the development of solar energy in upcoming countries like India. Solar energy, best suited for urban environment, can be housed in a limited space and is believed to be pollution free, environmentally friendly, as well as noise-free source of electricity. Among the currently present renewable energies, solar energy is considered to be an integral one, owing to its reduction in cost at an exponential rate day-by-day which is what this paper revolves around.

Objectives

Based on the literature review and the identified research gaps, the following are some possible objectives for this study:

- We have made this research paper to identify the barriers to renewable energy penetration and to suggest measures to overcome them.
- To identify and rank the adoption of "renewable and green" energy technologies in the context of India.
- To do a thorough assessment of the literature available and list the hurdles.
- To categorise the hurdles under different types such as economic, financial, regulatory, technical, etc.
- To analyse the different heads and provide the solutions available in ways of alteration and introduction of different policies and programmes.

Hypothesis

Based on the objectives, the following are some possible hypotheses for a study on the barriers to renewable energy in India:

H1: Social barriers: Social barriers have a significant influence on the deployment of renewable energy.

Social barriers have a significant influence on economic barriers.

H2**:** Economic barriers**:** Economic barriers have a significant influence on the deployment of renewable energy.

H3**:** Technological barriers: Technological barriers have a significant influence on the deployment of renewable energy.

Technological barriers have a significant influence on economic barriers.

H4**:** Regulatory barriers: Regulatory barriers have a significant influence on the deployment of renewable energy.

H5: Regulatory barriers have a significant influence on economic barriers.

3. Findings/ Results

The use of renewable energy sources has the potential to significantly reduce our dependency on fossil fuels and help combat climate change. However, a number of obstacles still exist that limit their wider use. Here are some significant discoveries and outcomes on obstacles to renewable energy:

Cost: One of the biggest obstacles to the adoption of renewable energy is cost. Renewable energy technologies are nevertheless often more expensive than conventional fossil fuels, despite their costs declining over time. Due to this, it may be challenging for renewable energy projects to compete economically, particularly in regions with already low energy prices.

Infrastructure: A further obstacle to the use of renewable energy is a lack of infrastructure. It can be costly and time-consuming to construct new infrastructure for renewable energy sources like wind and solar farms. It can also be challenging to integrate renewable energy sources into the grid because the current energy infrastructure is frequently not built to accommodate their intermittent nature.

Political and regulatory obstacles: Political and legal obstacles may make it more difficult to use renewable energy. Governments may lack the political will to encourage renewable energy sources or are swayed by influential fossil fuel interests. Furthermore, the growth of renewable energy may not be supported by regulatory frameworks, which can make it challenging for projects utilising renewable energy to get off the ground.

Public opinion: The acceptance of renewable energy sources may also be hampered by public opinion. Some people might not be aware of the possible advantages or may have doubts about the viability of renewable energy sources. Additionally, it could be challenging to secure public support for renewable energy projects due to worries about the aesthetic impact of solar or wind turbines.

Technological restrictions: Lastly, there are some technological restrictions that may make it more difficult to embrace renewable energy. Energy storage solutions, for instance, are still quite pricey and might not be able to offer the level of dependability required for particular applications. Furthermore, intermittent renewable energy sources like wind and solar can make it challenging to instantly match supply and demand.

Limitations

In this research, we have taken into consideration 4 types of barriers that affect the renewable energy advancement in India. The research may have only examined a limited number of barriers to renewable energy in India, potentially missing important factors that could affect the adoption of renewable energy.
This lacks quantitative aspect of the impact of such barriers. Generalization is yet another limitation as different research papers have been analyzed to arrive at the conclusion of the study. It is advised to practice caution when generalizing the findings in the context of renewable energy. This study needs to be validated by quantitative method as it is not a very representative finding.

4. Conclusion

Research was conducted to understand the barriers associated with the deployment of renewable energy and the benefits of overcoming these barriers. This research answers all the questions identified as part of the research objective.

Firstly, the factors affecting the deployment of renewable energy were identified and grouped into economic, technological and regulatory barriers. This research shows that economic, technological, financial and regulatory barriers have a strong influence on the deployment of renewable energy, while economic barriers, though not directly influencing it, and significantly influence it indirectly.

Finally, the research confirms that political implications have a big impact on the deployment of renewable energy. Technological barriers are preventing renewable energy from being efficient and preventing it from being cost effective. Social awareness and opposition also have a positive impact on the deployment of energy

5. References

A collection of SWOT factors (strength, weaknesses, opportunities and threats) for hybrid energy networks. (n.d.). Energy Reports 7 (2021) 55–61, 7.

Elavarasan, R. M., Afridhis, S., Vijayaraghavan, R. R., Bhaskar, M. S., & Nurunnabi, M. (2020). SWOT analysis: A framework for comprehensive evaluation of drivers and barriers for renewable energy development in significant countries. Energy Reports, 6, 1838–1864. https://doi.org/10.1016/j.egyr.2020.07.007

Khare, V., Nema, S., & Baredar, P. (2013). Status of solar wind renewable energy in India. Renewable and Sustainable Energy Reviews 27 (2013) 1–10, 27, 1–10. https://doi.org/10.1016/j.rser.2013.06.018

Elavarasan, R. M., Shafiullah, G., Padmanaban, S., Mustapha, A., Annam, A., Vetrichelvan, A. M., Mihet-Popa, L., & Holm-Nielsen, J. B. (2020). A Comprehensive Review on Renewable Energy Development, Challenges, and Policies of Leading Indian States With an International Perspective. IEEE Access, 8, 74432–74457. https://doi.org/10.1109/access.2020.2988011

Sharma, S., & Sinha, S. (2019). Indian wind energy & its development-policies-barriers: An overview. Environmental and Sustainability Indicators, 1–2, 100003. https://doi.org/10.1016/j.indic.2019.100003

Sharma, N., Tiwari, P. K., & Sood, Y. R. (2013). A comprehensive analysis of strategies, policies and development of hydropower in India: Special emphasis on small hydro power. Renewable and Sustainable Energy Reviews 18 (2013) 460–470, 18, 460–470. https://doi.org/10.1016/j.rser.2012.10.017

Yadav, K., & Sircar, A. (2021). Geothermal energy provinces in India: A renewable heritage. International Journal of Geoheritage and Parks, 9(1), 93–107. https://doi.org/10.1016/j.ijgeop.2020.12.002

Seetharaman, Moorthy, K., Patwa, N., Saravanan, & Gupta, Y. P. (2019). Breaking barriers in deployment of renewable energy. Heliyon, 5(1), e01166. https://doi.org/10.1016/j.heliyon.2019.e01166

Chakraborty, S., Sadhu, P. K., & Goswami, U. (2016). Barriers in the Advancement of Solar Energy in Developing Countries like India. Problemy Ekorozwoju, 11. http://yadda.icm.edu.pl/yadda/element/bwmeta1.element.baztech-549716df-8362-47a9-acae-e2a6a63c42a6