

Challenges Associated with Carbon Capture Technology Adoption by India

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Abstract--- Carbon capturing and sequestering technology is a manner of seizing atmospheric carbon dioxide from variant resources. The approach's utility is to restrict the discharge of large quantities of CO₂ in the atmosphere from anthropogenic sources. The technology is seen as a critical climate assurance technology for nations like India. The motive of the research is to analyse the challenges associated with carbon-capturing technology in India. Moreover, the advanced and latest technology that acts as the opportunity to capture and sequester the carbon is also discussed with the suggestion that it needs to be looked at effectively for human and environmental benefits. To obtain the challenges and opportunities in the carbon-capturing technology with the Indian perspective, various existing resources are keenly analysed and produce the relevant outcome. For effective research, the paper explored more than 60 papers and online resources in initial reading, and eventually, when writing the article, it selected 24 research papers. The outcome reveals that through the willingness of the administration to implement the inappropriate strategies effectively, cost-effective mechanisms and advanced technology are some measures to handle the challenges discussed in the paper.

Keywords--- Carbon capturing technology, Carbon capture technology adoption by India, Challenges Associated with Carbon Capture Technology

I. INTRODUCTION

Carbon emission and the burning of fossil fuels are the most prominent reasons for climate change and global warming. The primary source of intensifying atmospheric CO₂ concentration is the combustion of fossil fuel (Bruhn, T., et al., 2016). As the data revealed from the IPCC and the Paris climate change demonstrate that world is heating alarmingly, and the world is intended to keep every warming below two degrees centigrade, and this can be only accomplished by appropriate measures like adopt alternate resources of energy reduce fossil fuel exploitation enhancing and intensifying the carbon capturing and sequestering methodology which captures atmosphere carbon and maintains the CO₂ level in the atmosphere. As the latest report of IPCC indicates, carbon dioxide emission would need to phone by about 45% by the year 2030 from 2010 level and reach net zero by 2050 (IPCC report 2018). The concept of CO₂ capturing utilization and sequestration is commonly utilized to reduce carbon emission and maintain the carbon level in the atmosphere to protect the environment and prevent climate change (Selosse, S., & Ricci, O., 2017). Carbon capture and accommodation are assigned to the technologies that concentrate on eliminating carbon dioxide from the gas stream it comprises into a supercritical situation and decisively at transport and

sequestration in geological structures, containing depletion oil and gases reserves or oceans (Bui, M. et al., 2018). The international energy agency proclamation demonstrates that carbon-capturing has immense potential to subdue carbon emissions from all suitable manners in energy production. Manufacturing utilization embraces cement, iron and steel, oil refinery, pulp and paper, and biofuel industries.

Carbon capturing technology has received immense interest and attention since the last few years because the Paris conference and other environmental-based organizations proclaim that the available carbon in the atmosphere has enormous capability to intensify the atmosphere's temperature if we stop producing carbon emissions (Raza, A., et al., 2019). This advanced technology has the ability to capture carbon dioxide as a renewable carbon feedstock into valuable products instead of permanently sequestering it.

Global warming and climate change produce drastic risks over the countries, specifically developing countries suffering enormously, which will worsen food security, water unavailability, health issues, and the extent of biodiversity. India is a country that is facing enormous challenges because devastating climate change had its social, economic, and environmental vulnerable impact (Kumar, R., et al., 2019). India holds the fourth position among the largest carbon dioxide emission countries in the world. It was estimated that if India is rising at the same

speed, its carbon emission quantity will double in 2030. About 85% of the country's thermal power generation is coal-based, responsible for the most significant carbon emission, and the world's fourth-largest emitter. Around 65% of the Indian electricity generation capacity comes from thermal power plants (Gupta, A., & Paul, A., 2019).

Carbon capturing and sequestering technology is a manner of seizing atmospheric carbon dioxide from variant resources. The motive is to restrict the discharge of large quantities of CO₂ in the atmosphere from anthropogenic sources (Patil, P. G., 2020). The technology is seen as a critical climate assurance technology for nations like India, which can massively reduce CO₂ effusions associated with any other existing technology. It involves three significant steps (Sood, A., & Vyas, S., 2017).

- Capturing: separating carbon dioxide from other gases produced at extensive industrial process facilities such as coal, natural gas plant, oil and gas plant, Steel and Iron plant or a cement factory.
- Transportation: the carbon dioxide is compressed and transported through the pipeline, truck, ship, or other methods to a site suitable for geological storage.
- Storage: carbon dioxide is injected into the underground rock formation at more than one-kilometre depth.

Challenges of carbon capture from an Indian perspective:

The challenges associated with the commercial utilization of carbon-capturing in India are identified as (Shirmohammadi, R., et al., 2020).

- Lack of research and development initiative in the particular area, although it has immense potential to convert captured carbon into fuel or any other form.
- Lack of economic resources and unavailability of foreign direct investment.
- Demand for National level study to analyse the carbon dioxide storage potential.
- Expensive technology countries like India are still suffering from expensive advanced technology.
- Environment and legal concerns like land acquisition for groundwater contamination intensify the challenges.
- Political and policy-making issues and administrative unwillingness.

The motive of the research analysis is the carbon-capturing technology and how it plays a significant role in the future sustainable energy system in India. The paper also identifies the challenges before India while adopting carbon-capturing technology and how they can be resolved through dynamic, advanced technology.

1.1 Background

With the commencement of the industrial revolution in 1750, the social community began an age of intensified manufacturing exercise with the initiation of machines in the marketplace for generating cycles. Industrialization started the carbon emission because it is starting to use fossil fuel as a key energy source to work the modern industrial functioning appropriately (Kuk, M. et al., 2020). This constantly enhanced exploitation of carbon enables equipment, and excessive use of fossil fuel as an energy resource in the latest centenary has driven a great shift in the atmosphere in the sort of exaggerated greenhouse gas consistency (Gurjar, B. R., et al., 2015).

According to the intergovernmental panel on devastating climate report, carbon emanation from fossil fuel from various means like burning, manufacturing, and land-use transformation has expanded the CO₂ emission, changed the geographical terrain and converted into desertification, rising ocean level, global warming, ice melting among others. It is predicted that by 2035 the level of carbon dioxide of 450 PPM, the usually ratified description of the alarming level of environmental change, will be relinquished with a 77% to 99% possibility of surpassing 2-degree centigrade heating the planet (IPCC report, 2018).

This world facing hurdle could be even more critical because the pace of extension of carbon dioxide emission in the environment surpassed the adverse crisis as illustrated and outlined in the last few years (Irlam, L., 2017). The permanent and prolonging resolution of lessening greenhouse gas discharge needs to divorce energy utilization and CO₂ emanation. To deal with this concern, energy technology substitution and energy usage conversion require preferred power ability, expanded renewable source of energy, and the decarbonization of fossil fuel-based energy production (Mukherjee, M. et al., 2015).

An alternative resource of power and substitute fossil fuel use is the most promising and dynamic potential effort to reduce carbon emissions. However, fossil fuel facilities are expected to dominate the global power accumulation because they are the primary power reserve. Henceforth, carbon-capturing is examined as a mitigating action for carbon dioxide emanation and environment shift (Yadav, D. et al., 2016). It acts as a definite possibility to obtain the large-scale decrease in carbon dioxide lacked during this centenary.

1.2 Literature Review

Carbon capturing utilization and sequestration is one of the most distinctive alleviation approaches that India could utilize to manage greenhouse gas emanations efficiently. In the backdrop of a power sector originally commanded by core greenhouse and carbon emissions, one of India's most

traditional and prevalent hurdles (Garg, A. et al., 2017). Particularly, the seven-sister state, Assam in North-eastern India, is the last point source of carbon dioxide emissions like energy, chemical and manure factories. It has a huge sink in the design of a full-fledged oilfield, fuel area and many more. The paper analyses (Datta, A., & Krishnamoorti, R. 2019) the opportunity of low-carbon transmission through utilizing the carbon capturing and storing technology. The results demonstrate that implementing preparedness and plant design are the prominent factors that influence the economy and lead to colossal differentiation (Bruhn, T. et al., 2016).

India is a homeland with climbing energy demands because of the giant population and industrial requirements. Much of the power requirement is produced and fulfilled by coal, and there is a potent intersection between coal burning and commercial extension. However, overexploiting the nature of a human lead to devastating the environmental condition and increase carbon dioxide emission (Gupta, A., & Paul, A., 2019). The Indian energy industry provides approximately a maximum share of the Indian carbon dioxide eruptions, which cause greenhouse gases and pollution everywhere in the Indian continent. Henceforth Indian administration and Government impetus to reduce greenhouse gas emissions through advanced technology like carbon capture and accommodation procedure (Kumar Shukla, A. et al., 2020). The paper emphasizes the Indian power sector and the utility of carbon capture and storage technology near the coalfield. The influence of coal linkage and drain situation from the energy plant is installed using the studied examples. The trends in the post are predicted for the subsequent three decades for the forthcoming plant and analysis of the high carbon prices scenario (Kumar, R. et al., 2019). The research also emphasizes appropriate carbon-capturing technology used for Indian coalfield power plants and their potential by 2050.

Thriving climatic carbon intensity influences global well-being, economics and the overall nature of livelihood. We rapidly address an environment tipping position that must be greeted by decreasing emissions by utilizing innovation and progressive technological functioning towards carbon-capturing for sequestration (Viebahn, P. et al., 2014). For this perspective, the paper emphasizes biotechnologies for carbon-capturing innovative mechanism designing beliefs procured from environmental manners motivated by three dominant biomes: flora soil, the biosphere and aquatic life. It is noticeable to recognize attainable handle features of carbon dioxide and methane and utility connection possibilities that encourage innovation to develop ecosystems that inspire biotechnology.

The paper (Schweitzer, H. et al., 2021) also analyses geochemical carbon sinks with new bioengineering

solutions. The contemporary study explains the developmental strategies of emerging countries and how this country paves the way by adopting advanced technology like carbon capture and storage, which effectively handle greenhouse gases emission and other challenges created by climate change and global warming. The paper (Ray, A., 2021) highlighted several difficulties like lack of research and development initiatives in the particular area. However, it has immense potential to convert captured carbon into fuel or any other form. Lack of economic resources and unavailability of foreign direct investment and the demand for National level study to analyse the carbon dioxide storage potential.

The paper (Shirmohammadi, R. et al., 2020) identifies the technological rule, changing government assistance, and the obstacle against the growth of carbon capturing and certain strings to handle global warming. By analysing the existing technology, the paper determines the advantages and provides appropriate guidelines for making policies more applicable and effective in developing countries.

1.3 Research Gap

The research gap in the study is that the paper only associated with the carbon-capturing technology and related challenges while did not explore the diverse technology responsible for capturing, storing, sequestration and reutilizing the captured carbon for better and pollution-free purposes.

1.4 Research Question

Q. What are the Challenges Associated with Carbon Capture Technology Adoption by India?

Q. How to overcome challenges with adoption technology?

1.5 Importance of the Study

Because of climate change and global warming, the essentiality of carbon has become the need of the hour. Exploring the potential of carbon-capturing technology is enormously searching on the worldwide level. Countries that are generating extreme levels of carbon emission like India are desperately researching for new opportunities. Carbon emission is one of the most concerning and hot topics because of climate change and air pollution. The paper is concerned with the challenges and the advanced technology implemented for carbon-capturing from the Indian perspective. The research comprehensively analyses the latest technology relevant and responsible for carbon capture.

1.6 Research Objectives

The motive of the research is to analyse the challenges associated with carbon-capturing technology in India.

Moreover, the advanced and latest technology that acts as the opportunity to capture and sequester the carbon is also determined.

II. RESEARCH METHODOLOGY:

2.1 Research Method & Design

The paper selected the qualitative method to analyse the relevant information based on the secondary approach based on existing literature research. It uses secondary data from scholarly literature and online resources for research purposes. The study is systematically evaluated by employing online journals and national and international resources to conduct a smooth analysis and reach a conclusion. The paper looks at the report of IPCC, UNFCCC and other environmental organizations for obtaining the relevant information.

2.2 Research Approach

To obtain the challenges and opportunities in the carbon-capturing technology with the Indian perspective, various existing resources are keenly analysed and produce the relevant outcome. For effective research, the paper explored more than 60 papers and online resources in initial reading, and eventually, when writing the paper, it selected 24 research papers.

III. ANALYSIS OF DATA

In this outcome section the challenges and the opportunities are briefly discussed which reveal the barriers that came in front of India while adopting the carbon-capturing technology for sustaining and protecting the environment and mitigating the climate change devastating conditions.

Q. What are the Challenges Associated with Carbon Capture Technology Adoption by India?

Challenges for adopting the carbon- capturing technology in India:

Necessary strategy actions for carbon-capturing technology performed in India comprise interjecting a clear energy tax on imported and domestic systems, which goes into the National clean energy fund. In 2012 National action plan on climate change was extended to incorporate cleaned coal and available carbon technology to depreciate carbon dioxide emanations. In 2012, when the twelfth five-year plan was performed, it highlighted the requirement to spend in the research and development of ultra-supercritical factors. Institutes operating in the range for bringing out carbon dioxide capture and EOR are considered in Gujarat, Hyderabad, testing the workability of accommodation in a basalt composition. Several challenges are involved in the carbon-capturing technology, which can be roughly categorized as social, economic, technical and

environmental.

Social Challenges

Carbon mitigation through carbon-capturing technology will enable the usage of fossil fuels by the energy production sector and other carbon-intensive activities. Consequently, the synergistic influence of different pollutants like mercury, sodium dioxide, nitrous oxide, and dust particles on the well-being of regional societies and their enclosing atmosphere will persist unaltered.

Financial Challenges

An ample array of commercial expenses of carbon-capturing technology depends on carbon dioxide capture transport and sub-covering shot assets and performance. The cleaned coal technology impairs coal's capacity to overlook solar and other non-conventional sources and intensifies the expense of carbon dioxide capturing methodology. The exploration for the best suitable accommodation situation is also a lengthy and high-priced scheme. Henceforth carbon-capturing technology schemes essentially encounter the complications and ambiguity of cessation due to commercial crunch.

Lack of funding and significance of foreign direct investment implementation of high-priced carbon-capturing technologies claimed India's local and central administration investment inspiration. Good governance governments are endeavouring to attract foreign direct investment for the corresponding direction. Due to its immense expense, even after 30 years of technology evolution, the carbon-capturing methodology is still pursued as expensive to developing countries like India.

Environmental Issue

Storing carbon dioxide safely and stably will expect an efficient, convenient and appropriate inspection for the leakage measure of carbon dioxide back to the environment from inherent land-based and marine-based sequestration reserves. Furthermore, the shipment of seizing carbon dioxide and pumping it into oil and gas storages for the EOR (enhanced oil recovery) domain will use these fossil fuels. It will free the carbon dioxide back into the ambience. Henceforth comprehensive environmental monitoring for catching carbon-related technology obliges to be adequately surveillance through specialists before using technology to alleviate climate change problems. Like land acquisition, groundwater containment, the concern of carbon dioxide leakage creates environmental and legal considerations.

Technological Issues

The shortage of research and development exercises and the analysis aspect produce obstacles in the development of

advanced and cost-effective technology. Estimating its potential for transforming captured carbon into combustible ingredients or geological sequestration performs a decisive role. There is a requirement for prolonged national research on geological accommodation for carbon dioxide storehouse potential and its efficiency, requiring technological assistance.

Energy Penalty

The Carbon capturing technology also expects energy to persuade the occupied Carbon into favour, and India is grappling with its potential and energy replenishments requirement. This excess strain of using power is not worthwhile from a commercial and environmental point of view. Thus, energy penalty displayed a character of red tape in India.

Q. How to overcome challenges with adoption technology?

Opportunities for successfully implementing the advance carbon-capturing technology in India:

The framework proposed for the application of carbon-capturing technology for effective implementation and transformed it into a financial perspective in India through focussing on the several factors such as-

Policy and regulation mechanism

It comprises initiation of different economics for presentation and quick deployment of Carbon capturing and accommodation. The expansion of extensive national legality, administration, and guidelines for the multilateral prosperity entails a lately developed fossil fuel energy plant to be the carbon-capturing, spontaneous recovery of perception and awareness among the citizens and stakeholders of carbon capture technology. And its consequence and ascertainment of government function in inventing and promoting carbon dioxide shipment and storage infrastructure.

Identification of adequate suitable carbon dioxide storage locations

This intricate utilization of systems strengthening and promoting the storage investigation characterization and the growth of carbon-capturing schemes. Implementation of administration structure that assures the protection and practical accommodation extension with a coordinated worldwide methodology to intensify and modernize the knowledge of storage reserves. Furthermore, promote best disciplines with the assistance of research and development, latest technologies employing significant portions of carbon dioxide attending to their perpetual preservation from the atmosphere.

Improvement and cost reduction of carbon-capturing technology

One of the quintessential components was to diminish the power cost from energy plants outfitted with captured supplies through sustained technology development. Illustrated carbon dioxide capturing methods at a pilot order in modern pertinence translate research into valuable carbon-capturing technology and energy engendering cycle. That will dramatically decrease the expense of capturing and resource depletion by funding more potential on research and development collaboration with governments to reduce the furthermore electricity expense and resources track of fossil fuel plants furnished with capture.

Development of carbon dioxide transportation infrastructure

The policies promote the effective growth of carbon dioxide capturing and relevant transport infrastructure. It confirms that legislation and regulation fit the pipeline in transportation to foster a profitable atmosphere for carbon dioxide transportation and its geological accommodation, eventually reducing transportation costs and risks by bestowing understanding obtained from practice and promoting standard methodology.

IV. RESULTS & FINDINGS:

Carbon capturing technology should deal with commercial activities; technical assistance and support for indigenous capacity structure is the need of the hour. This action concerning technology transport and the associated economic service in emerging countries should be investigated and envisaged effectively.

Physical transportation of technology in a see-through practice should incorporate both technology care sections: availability of technology to meet the necessary condition of reduction of carbon emission and advanced technology essential for effectively capturing Carbon is a prerequisite. UNFCCC has explicitly involved one country economically and technically assists developing countries in overwhelming their environment change control mechanisms. These nations consider that the ultimate purpose of any optimization in the transport of carbon-capturing should not be restricted to installing this technology in emerging countries. This will commence coming innovation and guarantee the stability and long-lasting of carbon mitigation technology.

The commercial mechanism for transporting these technologies has also created a hurdle that has to attract a great deal of attention. International conferences like the Kyoto protocol and Copenhagen open the door for developing countries and provide responsibility to developed countries to appropriately transport gas emission

reduction technology to developing countries.

V. CONCLUSION

Global warming and climate change produce drastic risks over the countries, specifically developing countries suffering enormously, which will worsen food security, water unavailability, health issues, and the extent of biodiversity. India is a country that is facing enormous challenges because devastating climate change had its social, economic, and environmental vulnerable impact. Carbon capturing technology has received immense interest and attention since the last few years because the Paris conference and other environmental-based organizations proclaim that the available carbon in the atmosphere has enormous capability to intensify the atmosphere's temperature if we stop producing carbon emissions. This advanced technology has the ability to capture carbon dioxide as a renewable carbon feedstock into valuable products instead of permanently sequestering it.

According to the intergovernmental panel on devastating climate report, carbon emanation from fossil fuel from various means like burning, manufacturing, and land-use transformation has expanded the CO₂ emission, changed the geographical terrain and converted the environment by enhancing desertification, rising ocean level, global warming, ice melting among others. The Carbon capturing technology also expects energy to persuade the occupied Carbon into favour, and India is grappling with its potential and energy replenishments requirement. This excess strain of using power is not worthwhile from a commercial and environmental point of view. Carbon-capturing technology schemes essentially encounter the complications and ambiguity of cessation due to commercial crunch.

VI. FUTURE SCOPE

Carbon capturing is one of the most potential technologies although the technology is not new it's just the upgradation version or mechanical version of natural sequestration. The most tremendous use of this technology is to reuse the capturing carbon for better and renewable use and convert the waste emission into resources. The future scope of the research is to adequately implement the suggestion to reduce the carbon emission for the betterment of the environment and livelihood upliftment.

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