IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.67
Volume 5, Issue 4, March 2025

Carbon Capture and Sequestration-Current Scenario in India

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Abstract: *This paper provides an overview of the current scenario of Carbon Capture and Sequestration (CCS) in India. With India being one of the largest emitters of greenhouse gases, addressing the issue of carbon emissions is critical. This paper discusses various CCS technologies, government initiatives, challenges, and the potential for large-scale implementation in India to mitigate the effects of climate change. The paper also outlines the benefits and challenges of implementing CCS in the Indian context, including economic, technological, and policy-related aspects.*

Keywords: Carbon Capture and Sequestration, India, Greenhouse Gas Emissions, Climate Change, CO_2, Environmental Policy, Clean Energy

I. INTRODUCTION

India, as the third-largest emitter of CO_2 globally, faces the dual challenge of growing its economy while minimizing the environmental impact of industrial activities. As part of its commitment to reducing its carbon footprint, India has been exploring Carbon Capture and Sequestration (CCS) technologies, which aim to capture CO_2 from the atmosphere or directly from emission sources and store it in underground reservoirs. This paper explores the current landscape of CCS in India, examining its technological feasibility, policy support, and prospects for large-scale implementation.

II. BACKGROUND AND TECHNOLOGIES OF CCS

A. Carbon Capture Technologies

Carbon Capture Technologies primarily fall into three categories:

1. Pre-combustion Capture – This method captures CO_2 before combustion, typically in gasification processes.
2. Post-combustion Capture – CO_2 is captured after fossil fuel combustion, usually using solvents, absorbents, or membrane separation.
3. Oxy-fuel Combustion – This method involves combustion in pure oxygen rather than air to yield a concentrated stream of CO_2.

B. Carbon Sequestration Techniques

Sequestration of CO_2 can be divided into:

1. Geological Sequestration – Injecting CO_2 into deep underground rock formations such as depleted oil and gas fields or deep saline aquifers.
2. Ocean Sequestration – Capturing CO_2 and injecting it into the ocean.
3. Terrestrial Sequestration – Using biological processes like afforestation and reforestation to absorb CO_2.

India’s Carbon Emissions: Current Scenario

India's CO_2 emissions primarily stem from the energy, industrial, and transportation sectors. According to recent data, the country contributes to approximately 7% of global CO_2 emissions. The energy sector remains the largest contributor, with coal-fired power plants accounting for a significant share of total emissions. The country's continued reliance on coal, despite efforts to promote renewable energy sources, presents challenges for mitigating emissions.

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GOVERNMENT INITIATIVES AND POLICIES FOR CCS IN INDIA

A. National Action Plan on Climate Change (NAPCC)

India's NAPCC includes various missions aimed at reducing emissions and promoting sustainability. While CCS is not explicitly mentioned, the NAPCC's emphasis on clean energy and energy efficiency indirectly supports CCS technology research and deployment.

B. Policy Framework

The Indian government has begun to focus on CCS as a part of its low-carbon growth strategy. The Ministry of Environment, Forest, and Climate Change (MoEFCC) has initiated several pilot projects and feasibility studies on CCS.

C. International Collaborations

India has also engaged in international partnerships with countries like the United States, Japan, and Canada to develop CCS technologies suited to Indian conditions.

Key CCS Projects and Pilot Studies in India

Several pilot projects are currently underway to explore the feasibility of CCS in India:

1. The CCUS Pilot at NTPC: NTPC Limited, India's largest power producer, has been involved in a CCS project to capture and store CO_2 from a coal-fired power plant.
2. India's First CCS Initiative in Gujarat: The Gujarat State Petroleum Corporation (GSPC) has undertaken a pilot project in collaboration with the Canadian government to inject CO_2 into a depleted gas field.

These projects aim to assess the potential for large-scale CCS implementation in India and identify the challenges associated with infrastructure, costs, and regulatory frameworks.

Challenges and Barriers in Implementing CCS in India

A. Technical Challenges

1. Capture Efficiency: The efficiency of CCS technologies needs to be significantly improved for cost-effectiveness.
2. Storage Capacity: There is a need for extensive geological surveys to identify viable CO_2 storage sites.
3. Infrastructure: Building the infrastructure for CO_2 transportation and storage is a significant challenge.

B. Economic Challenges

1. High Capital Costs: CCS technologies require substantial initial investments.
2. Operational Costs: The ongoing operational and maintenance costs of CCS projects are high, making them financially unviable without external support.

C. Policy and Regulatory Challenges

1. Lack of Clear Regulations: There is a need for a comprehensive regulatory framework to govern CCS projects, including issues related to liability and long-term monitoring of CO_2 storage sites.
2. Public Acceptance: There may be public resistance to CCS projects due to concerns over the safety of CO_2 storage sites and their long- term environmental impact.

Potential for Large-Scale CCS Implementation in India

The large-scale adoption of CCS in India is crucial to meeting the country's climate goals. However, several factors must be considered:

1. Government Support: Strong policy backing and financial incentives are necessary to reduce the economic burden of CCS technologies.
2. Technological Innovations: Continued investment in research and development is required to improve the efficiency and cost- effectiveness of CCS methods.
3. Public-Private Partnerships: Collaborations between the government and private sector can drive the commercialization of CCS technologies.

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III. CONCLUSION

Carbon Capture and Sequestration technologies offer a promising solution to mitigate CO_2 emissions in India, but significant challenges remain in their large-scale deployment. India must continue to invest in technological advancements, create clear policy frameworks, and foster public-private partnerships to realize the potential of CCS. As the world's third-largest emitter, India has an essential role to play in global efforts to combat climate change, and CCS could be a key component of its long-term strategy to reduce carbon emissions.

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