Economics, Policies, and Al-Driven Strategies for CCUS: Incentives, Regulations, and Social Engagement

Objective/Scope

The successful deployment of Carbon Capture, Utilization, and Storage (CCUS) depends on technological advancements and economic feasibility, policy frameworks, and societal acceptance. This study explores the role of government incentives, regulatory policies, and Environmental, Social, and Governance (ESG) considerations in shaping CCUS adoption. Additionally, it examines how artificial intelligence (AI) enhances policy-driven decision-making, regulatory compliance, and social engagement, contributing to a sustainable and scalable CCUS ecosystem.

Methods

This study reviews global and regional policy frameworks supporting CCUS, including carbon pricing mechanisms, tax incentives, and funding programs. It evaluates economic models that assess the cost-effectiveness of CCUS projects under different policy scenarios. Furthermore, it investigates the role of AI in policy development, regulatory monitoring, and public engagement. AI-driven tools such as predictive analytics, digital twins, and automated compliance monitoring are analyzed to understand their impact on policy implementation, financial risk assessment, and stakeholder communication. A comparative analysis of existing CCUS projects highlights the effectiveness of economic and regulatory incentives in driving adoption.

Results

Governments worldwide are implementing new regulations and financial incentives to promote CCUS, including carbon credit systems, subsidies, and tax incentives. Policies such as the U.S. 45Q tax credit and the European Union's carbon trading schemes have significantly influenced investment in CCUS infrastructure. However, economic challenges remain, including high capital costs, uncertain carbon pricing, and financial risks associated with large-scale deployment. Al technologies provide solutions

by improving financial modeling, optimizing subsidy allocation, and automating regulatory compliance.

Beyond economics, AI enhances social engagement by analyzing public sentiment, developing transparent communication strategies, and predicting policy impacts on communities. ESG considerations are increasingly shaping CCUS adoption, with investors prioritizing projects aligned with sustainability goals. AI-driven analytics help companies align CCUS strategies with ESG targets, ensuring compliance with evolving environmental and social governance standards. The study highlights the necessity of integrating AI into economic and policy frameworks to accelerate CCUS implementation while addressing financial and social barriers.

Novelty

This study uniquely integrates economic, policy, and Al-driven approaches to CCUS adoption. Unlike previous research, it provides a holistic view of financial incentives, regulatory frameworks, and Al's role in optimizing decision-making and social engagement. By presenting real-world examples and future research pathways, this work shapes policy-driven strategies that enhance CCUS scalability and long-term viability in achieving net-zero goals.