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Carbon Capture and Storage: Critical Analysis of Its Role amidst Net-Zero Pathway

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Abstract: This article will analyze the role of carbon capture and storage technology (CCUS) in achieving a net-zero emissions path. In his article, author Naoko Ellis introduces the development, innovation, problems and challenges of CCUS, and believes that although CCUS technology has high risks and high costs, and may have a negative impact on the progress of renewable energy, CCUS should be taken into consideration when addressing complex climate issues. The article discusses the relationship between CCUS technology and renewable energy, especially its role in the energy system, and points out that CCUS technology is more applicable in heavy industry, such as high-emission industries such as cement and steel. The author also believes that in order to achieve net zero emissions, CCUS technology should be one of many technologies and coexist with other carbon reduction technologies. However, the article also mentioned that the progress of CCUS technology is far below expectations, and its high costs and uncertain risks still need further evaluation.

Keywords: carbon capture and storage technology, net-zero emissions.

1. Introduction

As the challenge of decarbonization can no longer be neglected, most countries in the world have set or are considering a target to reach net-zero by mid-century. Naoko Ellis, in her article "Why Carbon Capture and Storage is Key to Avoiding the Worst Effects of the Climate Emergency," introduces the development, innovation, problems, and challenges of Carbon Capture and Storage (CCS) or Carbon Capture, Utilization, and Sequestration (CCUS) as an approach to reducing greenhouse gas emissions. She claims that despite the high risks and costs of CCUS, as well as its negative impact on the progress of renewable energy, which deserves widespread concern, CCUS technologies should be described in detail and considered within an industry context. Given the feasibility and success of CCUS projects, we should be open to all available tools in the face of complex climate issues.

I will begin by illustrating the context and following Naoko's logic to discuss the adequacy of the rationale for the development of CCUS. Additionally, considering the non-linear thinking about CCUS put forward by the author, I will explore the underlying connection between CCUS technology and renewable energy in their roles within the overall technical framework for building a flexible and resilient energy system, which undoubtedly advances the establishment of a low-carbon society. Eventually, I will use discourse analysis to demonstrate that this article indicates there is going to be a portfolio of various technologies that will help to reach net-zero.

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2. Overall Context of the Article

As substantial worries have been raised about the cumulative effects of climate change and experimental emission reduction strategies for a net-zero and sustainable future constantly emerge, there are serious risks to global decarbonization posed by the lack of social confidence, successful and mature technology, and incentives to scale up deployment. In the context of 1.5℃ pathways, it is currently crucial to enhance collective understanding of the issue and build consensus. Carbon Capture, Utilization, and Sequestration (CCUS) is a technical combination that can satisfy the requirement for climate target in a variety of ways [1].

The final adoption of any emission reduction technology will be largely determined by the level of public acceptance, so each technology option has to strive for the trust of the public to expand and deploy on a large scale. In modern society, CCUS technologies have not been aware by public, and many people are suspicious about CCUS as a method to extend the life of fossil fuels. Lack of public acceptance may be the largest non-technical risk of CCUS projects implementation [2]. I think this is the original intention of the author in writing this article.

By reading this article, we can see that the author is committed to advocating for CCUS technologies. Through research, it is evident that the Canadian Natural Sciences and Engineering Research Council (NSERC), which sponsors the author, is a government agency that financially encourages CCUS research and fosters collaborative initiatives between academic researchers and industry players working in this field. Clearly, Naoko's advocacy for CCUS aims to increase public acceptance of this technology. Therefore, I am unsure whether the success of some CCUS projects deployed by Naoko's sponsor in Canada and her identity as a CCUS practitioner have led to subjective perspectives and extra optimism.

2.1. Comprehensive Assessment of CCUS

The first question to consider is whether CCUS is worth investing in simply as a decarbonization technology. In the text, Naoko indicates that CCUS technology has already been maturely applied, technically improved, and commercialized on an industrial scale; all these positive developments inspire public faith in it. It seems to me that these statements are quite personal. According to research, there is no denying the progress in scaling up CCUS over the past two decades, and it has been identified as an economical strategy that quite a few countries are actively promoting [3]. The author illustrates the long development history and obvious technological progress of CCUS with the world's first commercial-scale carbon capture and storage project and several innovation examples. However, a simple vertical comparison cannot certify that this technology is going to be the optimal solution for controlling emissions. To some extent, the opinions of stakeholders often seem too biased to convince people.

In fact, by 2021, the efficiency of decarbonization had doubled in the past decade but the capture level only reached 0.04 Gtpa, with carbon being captured globally by only 24 plants, which is less than 0.1% of global energy- and process-related emissions [4]. The data shows that even with a significant increase in decarbonization capacity, the progress of CCUS technologies has shown characteristics of over-promising and under-delivering.

So far, the obvious advantage has not been presented in this sector. What's worse, the industry is starting from a very low base, given the substantial deployment and implementation period for CCUS infrastructure, it will be many years before carbon capture starts to have a significant impact on emissions. She also claims that as researchers upgrade the technological process and adopt more efficient versions, the cost of carbon dioxide capture and conversion will decrease. Unfortunately, she notes that "they will remain costly even in the best of scenarios." Meanwhile, some external factors such as economic constraints and the lack of profitable sources worsen the situation.

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Facing this situation, we need more powerful support, such as competitive technological advancement, policy backing, regulatory adjustments, and effective economic measures like reasonable carbon pricing. Clearly informing readers of the authentic problems and how we plan to solve them will be more convincing than just emphasizing progress and potential.

Overall, there is no doubt about the feasibility of CCUS technology in emission reduction, but in tackling uncertain risks, controlling costs, and other long-term influences, it is absolutely necessary to further assess the sustainability and practical effects of this technology.

2.2. CCUS for Energy Transition

Among Naoko's narrations, another crucial viewpoint is that CCUS technologies can provide a much-needed technical solution during the transition period, under the circumstance that new energy has not yet grown powerful enough to thoroughly replace fossil fuels. However, there is a potential contradiction in her statement in the article: "carbon capture technologies have been labeled as a distraction from supporting renewable energies and as extending the life of the oil and gas industry." CCUS acts as treatment at the end of the process, while new energy controls carbon at its source. From a technical perspective, as time goes by , CCUS can only be compatible with a net-zero future under the circumstance that carbon source is uncontrolled or the utilization causes long-term storage of CO_2[4].

To address this concern, the author explains in the article that "we need to look at industrial emissions in various sectors in context." She emphasizes the importance of CCUS for heavy industries such as cement and steel, which contribute substantially to carbon emissions in Canada, while renewables are not as useful in this sector. However, we can easily provide a counterexample. In the electricity sector, new energy often outperforms CCUS in both economic cost and sustainability. Moreover, it has been predicted that frequent occur of renewable energy and drop in energy intensity level, will be the mainstay of a net-zero pathway, accounting for 80% of decarbonisation in a 1.5°C scenario. For now, carbon capture and storage have made no meaningful contribution to reduce greenhouse gases globally, and only in specific circumstances does new energy need to be supplemented by CCUS technology [4]. Consequently, the development space and value of CCUS technologies are gradually being squeezed.

There are completely different situations regarding the deployment of new energy strategies and CCUS technologies in different countries, industries, sectors, and specific project contexts. Decisive factors include: the costs of the entire process; the practicalities of implementation; availability of supporting transport and storage infrastructure; actual emissions mitigation amount; deployment timeline; expertise and knowledge; external influences; social attitudes and public acceptance [4].

The author calls for people to believe in the development of CCUS technologies and accept the fact of paying for decarbonization. However, without fully competitive pricing or strong technical support, CCUS will never be "the most handy tool" for reaching a net-zero society and economy. Moreover, technologies for carbon capture, utilization, and sequestration should not be a tool for extending the life of fossil fuels, but they really play a significant part in dealing with aspects of emissions mitigation and energy transition, which has greatly surpass other technologies.

2.3. Net-Zero Technology Portfolio

As Mercedes Maroto-Valer, director of the Research Centre for Carbon Solutions at Heriot-Watt University has said "It's not going to be just one technology that is going to help us reach net zero,It's going to be a portfolio of different technologies that are going to be ready at different times"[5]. This opinion supports the scientific validity and rationality of the formulation that the author claims CCUS

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can satisfy the urgent demand to decarbonize now while renewable energy sources replace fossil fuels to produce electricity in the future.

No single energy transition model can be suitable for all countries; there are so many influential factors. Each country, each sector, and even each project will choose its own deployment framework and approach according to their energy situation and their demand for resource security and sustainability [2]. For instance, areas where renewable energy resources are abundant tend to depend on these resources more, while other areas rich in fossil fuel resources will depend more on CCUS technologies. As the author mentions in her article, CCUS technologies play a more effective role in traditional heavy industries such as cement and steel, where carbon dioxide is released from the material used in the process rather than through combustion [6].

Additionally, the high cost is not a problem unique to developing CCUS technology. In fact, all energy transition pathways will be costly, due to the capital-intensive feature all supply-side technologies have [2]. Rather than creating an antagonistic relationship between various technologies, it is better to let them coexist and complement each other. In such a framework, there will be more tolerance for the incomplete and inadequate development of technologies. As the author says in her article, “Let’s shift the narrative on CCUS and reduce carbon emissions with all the available tools.”

3. Conclusion

In conclusion, the target article “Why Carbon Capture and Storage is Key to Avoiding the Worst Effects of the Climate Emergency” presents the progress in CCUS technologies to activate public support. Through discourse analysis, I have demonstrated how the author tries to persuade people to trust in the development of CCUS. Based on the background and standpoint of the author, I remain cautious about her appeal for CCUS. We should evaluate its strength on a realistic competitive platform, clearly facing its pros and cons. Moreover, for carbon reduction and energy transition, we should consider CCUS and any other decarbonization technology from the perspective of macro-strategic deployment and combine it with the actual development level of the technology, rather than blindly being optimistic and supportive or negative and opposed.

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