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The Role and Institutional Impacts of Carbon Dioxide Removal Technologies in Climate Governance

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Abstract. As the global climate crisis intensifies, and with the establishment of the 1.5℃ temperature control target by the Paris Agreement, relying only on emission reduction makes it difficult to reach the net zero target. Therefore, Carbon Dioxide Removal (CDR) is accelerating towards early commercialization and becoming a key strategy for global climate governance in climate governance discourse has changed significantly. From the "Supplementary Options" in the IPCC Fifth Assessment Report to the "scientifically necessary path" for the 1.5°C temperature control target, CDR has now been elevated to the third pillar of global governance alongside "emission reduction and adaptation". This paper adopts the document analysis method and comparative analysis. The study found that CDR has completed the institutional transformation from "supplement" to "dependence" in climate governance discourse, but this transformation may produce a "moral hazard" effect - that is, excessive commitment to immature technologies may weaken the motivation for current emission reduction.

Keywords: Carbon Dioxide Removal (CDR) Technology, Climate Governance, Net Zero Emissions, Moral Hazard, Institutional Dependence

1. Introduction

As the Paris Agreement sets out the goal of limiting global warming to 1.5°C, the core challenges of global climate governance become more clear: there is still a huge gap at present between the emission reductions promised by the national autonomous contributions submitted by countries and the emission reductions required to achieve the temperature control target [1]. International climate science agencies and the Intergovernmental Panel on Climate Change (IPCC) note that normal emissions cannot offset residual emissions, and that CDR is a critical last mile in the net-zero transition. In this background, Carbon Dioxide Removal Technology (CDR) has gradually entered the central vision of climate policy and academic discussion.

However, the status of CDR in climate governance has not always been this important. From the "Supplementary Mitigation Program" in the IPCC Fifth Assessment Report, to the core positioning of "Almost Paths Require CDR" in the "1.5℃ Special Report", and to the Sixth Assessment Report, CDR has been institutionalized and it has been confirmed that CDR has completed a fundamental "discourse upgrade" [2-4]. However, CDR technology does not yet have the conditions for large-

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scale deployment, and there is a significant tension between its dependence and its actual feasibility [5].

The core research question of this paper is: How has the role of CDR evolved and developed within climate governance? What kind of institutional effect does this evolution produce? In order to answer these questions, this paper adopts the document analysis method and the comparative analysis method, and systematically shows the changes in the expression of CDR in previous IPCC reports, COP resolution texts and Chinese NDC documents [6]. This research is beneficial for deepening the critical understanding of basic "net zero" target system and provide a reference framework for assessing the reliability of countries' climate commitments.

2. Concept and feasibility analysis of Carbon Dioxide Removal Technology (CDR)

2.1. Conceptual definition and technical route of CDR

Carbon Dioxide Removal (CDR) refers to a collection of technologies that actively capture carbon dioxide from the atmosphere by human means and achieve long-term sequestration. The fundamental feature that distinguishes it from traditional "emission reduction" is that emission reduction is to reduce new emissions, while CDR is to remove existing emissions. IPCC defines CDR as "human activities that remove carbon dioxide from the atmosphere and permanently store it in geological, terrestrial or marine reservoirs". According to differences in technical principles and maturity, there are three main CDR pathways at present.

Firstly, Bioenergy with Carbon Capture and Storage (BECCS), that is, by planting energy crops or using the combustion of agricultural and forestry waste to generate electricity, the CO_2 generated by combustion while releasing energy is captured and injected into the underground geological structure for permanent sequestration. Its advantages lie in its "two-sided function": it can not only produce energy but also achieve "negative emissions"; however, it also faces significant land competition problems [7].

Secondly, Direct Air Capture and Storage (DACS/DAC), that is, using chemical adsorbents or absorbents to "filter" CO_2 directly from the ambient air, separate and purify it and inject it into geological reservoirs for segulation or industrial raw materials. Its advantage is that it does not occupy land and can be set anywhere, but its core challenge is its extremely high energy consumption and economic cost - the capture cost of CO_2 per ton is about 600-1000 US dollars at present [4].

Thirdly, Nature-based carbon removal solutions (NbS), including afforestation/reforestation, soil carbon fixation, blue carbon (mangroves, seagrass beds, etc.) and other paths. This approach has advantages in low cost and high technical maturity, but it faces the risk of non-permanent carbon sinks - forest fires, pests and diseases, land use changes, etc. may cause the re-release of fixed carbon back to the atmosphere [8].

2.2. The gap between the practical ability of CDR and the dependence on goals

In order to understand the evolution of CDR discourse, it is necessary to understand the gap between its real ability and the ability assigned to it in the policy text. In terms of orders of magnitude, this gap is amazing:

The current annual capture of global DAC: about 10,000 tons of CO_2 (i.e. 0.01 million tons)

Total global annual emissions: about 37 billion tons of CO_2.

The ratio of the two: about 1 : 37,000.

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In other words, the current removal of DAC facilities around the world is only equivalent to about 37,000th of the world's annual emissions. Even if all CDR paths such as BECCS and afforestation are combined, their current contribution is still insignificant compared with the global emission scale [5].

Because of this huge gap between real ability and target dependence, it constitutes the background of understanding the evaluation of CDR discourse.

3. The evolving role of carbon removal in climate governance

In this background, the role of CDR in climate governance has undergone three stages of change.

3.1. CDR's "cautious debut"

The fifth assessment report of IPCC (AR5) is the first time that CDR has received systematic attention in the IPCC assessment framework. AR5 positions CDR as "a complementary option in the mitigation portfolio" and clearly states that it faces "major uncertainties, risks and trade-offs in sustainable development" [2]. According to AR5, using CDR has specific condition, only when "strengthening emission reduction is not enough to achieve the goal" needs to be considered. This period reflects that CDR was regarded as a "last method", but not as the core path.

3.2. The "center of gravity shift" of CDR

The 1.5℃ Special Report (SR1.5) released in 2018 indicates a key turning point in the evolution of CDR discourse. The report clearly states: "All paths that limit the temperature to 1.5℃ require some form of carbon removal" [3]. It means that the status of CDR has improved from "optional" to "almost must-have". However, SR1.5 also retains an important warning statement: "There is a risk of over-reliance on CDR, which may slow down efforts to deep emission reduction" [3].

3.3. "Institutional confirmation" of CDR

The sixth assessment report (AR6) further ensures the core position of CDR. AR6 not only systematically discusses CDR in many reports of the working group, but also fits it into the mainstream framework of climate governance in the comprehensive report. It is worth noticing that conditions and warning language accompanying CDR expression in AR6 have been reduced in proportion, while the specific description of the necessity statement and deployment scale has increased significantly [4].

Comparing AR5, SR1.5 and AR6, one can clearly see the evaluation of CDR discourse and the improvement of its status and impact. Therefore, we could clearly see its transform: the positioning has risen from "supplementary options" to "core elements"; the tone has changed from "conditional" to "almost certain"; the frequency of appearance and discussion space have increased significantly; the discourse has spread from the IPCC system to the negotiation system (COP).

The change of discourse in the IPCC report does not exist in isolation. It is gradually transmitted to the institutional level of international climate governance through the COP negotiation process and the preparation of national independent contributions. This conduction process is particularly evident in the text of the COP resolution and China's NDC.

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4. CDR's institutional positioning in international climate negotiations and typical national policies

4.1. CDR in the text of the COP resolution: from implicit to explicit

CDR is not explicitly mentioned in the text of the Paris Agreement, but the "net zero" target (Art. 4.1) logically implies the demand for CDR - because "net" means that some of the hard-to-cut emissions still need to be offset by removal [1]. In subsequent COP meeting, the prominent mention of CDR gradually increased. The Glasgow Climate Convention of COP26 explicitly refers to "carbon removal" and "negative emission technology" in the text of the resolution for the first time, and emphasizes the need to "accelerate technology development and deployment" [9].

However, at present, the carbon market mechanism under the framework of Article 6 of the Paris Agreement still lacks sufficient institutional constraints on the "additionality" and "permanence" of carbon removal, which means that the contribution of CDR may be overestimated or recalculated.

4.2. CDR positioning in China's NDC - institutional risks of technology dependence

China's national determined contribution (NDC) provides a typical case for observing CDR institutional discourse at the level of major emission countries. China's NDC and the Medium- and Long-term Low-Carbon Development Strategy highlight expressions such as "increasing forest carbon sinks" and "developing low-carbon technologies such as CCS", and treat carbon sinks and CCS as important support mechanisms for achieving the goal of carbon neutrality. Compared with other major economies, China is more dependent on carbon removal pathways, which is directly related to China's coal-based energy structure [10].

This "technology dependence" discourse can produce systemic impacts in two aspects: first, it alleviates the political pressure of completely eliminating fossil energy in the short term; second, it may delay full investment in alternatives to renewable energy.

4.3. Institutional effects and risks of CDR discourse

All in all, the systematic evaluation of CDR in climate governance discourse has a double effect.

The positive effect is that the inclusion of CDR in the mainstream climate discourse broadens the policy toolbox, provides a possible path for the "last kilometer" of emission reduction, and improves the political feasibility of countries to set higher goals to a certain extent.

The negative effect is more alarming. The core insight of discourse theory is that discourse not only describes reality, but also constructs reality. When "net zero" becomes a universal goal and CDR becomes its institutional support, a "moral hazard" effect arises - policymakers and the public may delay the emission reduction actions that could have been taken now because they believe that "future technology can solve it" [6]. At the same time, the institutional construction around CDR (accounting rules, regulatory framework, attribution of responsibility) obviously lags behind the speed of its discourse expansion, so that "net zero" may to some extent become a kind of "literal compliance" - that is, a textual expression that meets the target but does not achieve real zero emissions.

5. Conclusion

This paper analyses the change of CDR's status in IPCC Assessment Reports, COP Resolution Texts and China's NDC, which reveals the systematic process of CDR from "supplementary option" to

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"core dependency path" in international climate governance. The research finds that this change is not only based on the improvement of maturity, but also "constructed" as a core element under the institutional logic of climate governance.

However, the CDR discourse system has produced a conflicting double effect. On the one hand, it broadens the path options for climate governance and makes the "net zero" goal operational at the discourse level. On the other hand, excessive institutional dependence on immature technology may induce "moral hazard" - weakening the motivation for current deep emission reduction and delaying the withdrawal process of fossil energy by "technical commitment".

The limitation of this study is that it is mainly based on text analysis, does not quantitatively evaluate the degree of dependence on CDR, and does not systematically compare the differences between different countries. Future research can be deepened in the following directions: first, establish a quantitative and comparative framework for the dependence of NDCs on CDR in various countries; second, track the evolution of CDR accounting rules in the negotiations of Article 6 of the Paris Agreement; third, analyze how fossil energy interest groups promote the discourse of "technology retention" from the perspective of political economy. In a word, only when the institutional construction of CDR and the expansion of discourse are promoted simultaneously will "net zero" not be reduced to an empty promise of "literal compliance".

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