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The post-carbon society: Rethinking the international governance of negative emissions

Espen Moe[a,*], Jo-Kristian S. Røttereng[b]

[a] Department of Sociology and Political Science, Norwegian University of Science and Technology, 7491 Trondheim, Norway
[b] City of Trondheim Climate Action Plan, Environmental Section, Trondheim Municipality, Norway

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ABSTRACT

This article makes an early attempt at connecting political science insights on the politics of carbon sequestration to a growing demand for knowledge about the potentials of negative emissions. Negative emissions from sequestering carbon is likely to be vital for fulfilling the 2 °C target. Thus, this article is a reality check on what states *actually* plan to do. Based on key states' nationally determined contributions (NDCs) to the international climate regime and off-the-record interviews with senior country representatives to the 2016 climate meeting in Marrakech, we find that states generally do *not* have policies to promote large-scale carbon sequestration or negative emissions. However, many states wish to make the most of terrestrial sinks, using current regime rules as part of their mitigation portfolios. We suggest that national strategies to promote negative emissions will remain absent until the international climate regime formalizes rules and incentives for such efforts, recognizing them as legitimate national contributions. Without a governance framework that admits such efforts, national initiatives on large-scale negative emissions cannot fulfill the purpose of climate policy in a two-level setting matching national interests and international commitments.

1. Introduction

The Paris Agreement commits states to keeping the increase in global average temperature this century to "well below" 2 °C [1,p.3]. The task of staying below this 2 °C target has been left to the sum of what states present in their Nationally Determined Contributions (NDCs) to the international climate regime. The hope and assumption is that in time the sum of national actions will converge towards achieving this shared ambition [2]. It is a "coordination light" approach to a formidable task [3].

So far, the sum of all stated NDC pledges are however patently insufficient to put us on a global trend to meet the target. Even with all pledged actions put into effect, we will see warming of 2.9–3.4 °C [4,5]. Achieving the 2 °C target will most likely imply that global greenhouse gas (GHG) emissions have to turn *net negative* in the second half of the century [6], as in "the deliberate removal of CO_2 from the atmosphere by human intervention" [7,p.850]. In other words, we need to create a post-carbon society. Of the Intergovernmental Panel on Climate Change (IPCC) scenarios consistent with reaching the 2 °C target by more than a 50% likelihood, 87% assume widespread negative emissions [6]. This essentially means that taking the Paris Agreement seriously requires that we engage with the relatively unproven and controversial class of mitigation measures called negative emissions technologies (NETs).

The question then becomes; if it is improbable that we reach the 2 °C target without NETs on a large scale, should we not expect states to spend considerable effort on developing NETs? This we however do not see. This article therefore seeks to answer if and why (not) states pursue policies that correspond to the fact that the backbone of successful collective action on climate change mitigation rests on the use of NETs.

While the NETs literature is rapidly increasing, it is still small, in 2015 accounting for only 1% of the overall climate change literature.[1] Of these articles, less than 5% are from the social sciences [8].[2] Even fewer contributions have studied NETs in global climate governance from a political science perspective, although recent headlines now report that governments are beginning to add NETs research to public budgets. The United Kingdom in 2017 allegedly became the first

* Corresponding author.
E-mail address: espen.moe@ntnu.no (E. Moe).

[1] Much of this literature underlines the need for more knowledge of their material consequences, warning of wide-ranging adverse effects on biological diversity, freshwater and nutrient restraints, and land-use conflicts from putting NETs to work [7,29,89].

[2] Out of roughly 3000 NETs articles since 1991, only 5.4% address institutions and governance. While social science articles have increased in absolute numbers, they account for a smaller percentage of the overall pool of articles now than in 1991. Thus, in 2016 more than 95% of the articles on NETs came from the natural sciences, agricultural sciences and engineering and technology [8].

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country to set aside funding specifically for NETs research, and the US Department of Energy also has grants for carbon-capture technologies. However, so far the sums are negligible (£8.6 million and $26 million) [9], and in general, the governance of NETs has been given very little attention.

Some worry that the global governance of NETs has moved *too fast* without a proper scientific understanding, as seen with the Convention on Biological Diversity's (CBD) decisions to discourage geoengineering in 2010 [10]. Others suggest that the problem is *too little* policy at the international level, arguing that we will not see much experimentation with NETs unless a governance framework to encourage this is established [11]. Either worry demonstrates the importance of studying NETs politics and governance.

Given the knowledge gaps and the importance of the issue, this article attempts to add to a few pertinent contributions. The NDCs submitted to the international climate regime meeting in Paris in 2015 and, one year later, to the climate regime meeting in Marrakech, provide us with a great opportunity to take stock of how and to what extent states are prioritizing negative emissions, at present and for the future. Our data is based on the NDCs available by the Marrakech meeting in 2016, in combination with personal interviews with senior representatives from the delegations of seven of the world's 15 largest GHG emitting countries, present in Marrakech.

NETs *per se* has not to any great extent yet been studied empirically. Thus, to tie prospective NETs to what we actually *can* study on empirical terms, this article draws on the assumption that support for other carbon sequestration-based mitigation concepts represents a necessary step one for a policy that will eventually embrace carbon stock maintenance from NETs. Most NETs are based on carbon sequestration in one way or another, but not all carbon sequestration yields net negative emissions. However, there *are* empirical examples of carbon sequestration in global climate politics that in theory may yield negative emissions, and as such conform to a broad definition of NETs as all types of measures that remove CO_2 from the atmosphere by human intervention, even if they are not commonly described as NETs. The three most obvious include the climate regime's rules for accounting for anthropogenic activities from Land-Use, Land-Use Change and Forestry (LULUCF), the international mechanism for Reducing Emissions from Deforestation and forest degradation in Developing countries (REDD+), and methods for geological carbon sequestration using carbon capture and storage (CCS) methods. We suggest that the politics of these approaches to carbon sequestration are key to assessing the politics of sequestration leading to net negative emissions. For example, Bio-Energy CCS (BECCS) warrants an operational CCS value chain. Similarly, LULUCF is all about afforestation and reforestation (A/R), as is REDD+ when it comes to intermingling so-called "fossil" and "biological" carbon in national mitigation portfolios. If the world's emitters are planning for any large-scale carbon sequestration based on existing frameworks for geological storage or biomass-based carbon sinks, we argue that this implies adhering to the worldview of the IPCC and research community at large; namely that a global effort is needed not only to curb carbon *flows* but also to manage carbon *stocks* to achieve substantial negative emissions. What we however find, is that this is certainly not the case.

After systematizing a bewildering array of NETs-related concepts, we suggest using the framework of international politics as a two-level game as a vantage point to analyze NETs. States need simultaneously to balance national interests and international norms, as NETs need to fulfill *a political purpose* for states [12–14]. Few NETs, however, actually do that under the current regime. What comes closest to fulfilling a political purpose are activities under the LULUCF rules, as the Paris Agreement offers liberal carbon counting rules for national, terrestrial carbon sinks. But while the Paris Agreement's NDC mechanism may prove helpful for mounting national ownership to *some* mitigation actions, this does not apply to most other NETs under the current governance framework. Our suggestion is that as long as the climate regime does not reward states for national efforts on NETs, and as long as NETs do not serve any political function in the two-level game, the Paris agreement's "coordination light" approach will be insufficient for new NETs to become public policy to a degree where it actually makes a difference in curbing emissions. Thus, it comes as no surprise that, with the exception of LULUCF, efforts have so far been very limited, as the empirical section establishes that states' efforts on carbon sequestration and NETs fall far short of the implicit Paris Agreement recommendations. More governance efforts are probably required for new NETs to be realized, with the lack of an international framework for the experimentation with NETs for climate policy purposes a key impediment.

2. Concepts and literature

Besides the Fuss et al. [7] emphasis on the deliberate removal of CO_2 from the atmosphere by human intervention, negative emissions and negative emissions technologies (NETs) have also been labeled "geoengineering" [15], "carbon dioxide removal" (CDR) from the atmosphere [16] or "greenhouse gas removal" [17]. Because CDR implies manipulating the global carbon cycle, most CDR also fits the controversial "geoengineering" category [11,16].[3] Note however that all "geoengineering" activities are not NETs, as the former is preoccupied with modifying any climate relevant earth system.[4] NETs, in contrast, is focused solely on CO_2 removal. Unlike traditional mitigation measures, NETs are also less concerned with whether the removed CO_2 stems from humans or from natural flows.[5] Thus, most NETs are by definition based on carbon sequestration and the two terms are used interchangeably in the following.

By *carbon sequestration* we understand all approaches to "capturing and securely storing CO_2 that would otherwise be emitted to or remain in the atmosphere" (18, p.277).[6] Conceptually, without considering system boundaries and re-growth times, this may be done based on photosynthesis by increasing CO_2 uptake in the climate system's reservoirs and sinks. A/R are the most notable photosynthesis-based methods for enhancing terrestrial sinks [19].[7] In the ocean, iron could potentially be used as a fertilizer to stimulate primary production [20]. One might also capture CO_2 from the atmosphere using mechanisms besides photosynthesis. Such options include soil carbon management techniques, like biochar [21]. Direct Air Capture (DAC) is a label for chemical engineering-based measures to extract CO_2 from air [22]. In the ocean, it may be possible to boost the geochemical fixation of CO_2 uptake using lime or silicate [23,24].

Beyond capturing CO_2 from reservoirs in the climate system, there is traditional CCS as we know it from industrial value chains, or "non-NETs carbon sequestration from other sources" [25]. CCS conceptualizes a sequence of technologies where CO_2 is captured, transported and finally stored away from the atmosphere in geological formations [26]. Such "traditional" industrial CCS is included here because it constitutes the pre-required sequestration processes for key NET concept BECCS. While CCS was originally intended for fossil fuels, BECCS expands the scope to include CO_2 from biomass, turning CCS value chains into a NET [27].

[3] The IPCC, however, defines only CO_2 capture from the atmosphere as Carbon Dioxide Removal (CDR), directly fitting the NETs definition [90,p.1254]: "A set of techniques that aim to remove carbon dioxide (CO_2) directly from the atmosphere by either (1) increasing natural sinks for carbon or (2) using chemical engineering to remove the CO_2, with the intent of reducing the atmospheric CO_2 concentration."

[4] Focusing on carbon removal excludes so-called "geoengineering" techniques that do not remove carbon, such as for instance solar radiation management [16,91].

[5] Mitigating emissions from anthropogenic activities has been the preoccupation of the international climate regime [90].

[6] Irrespective of the CO_2 source or whether the CO_2 is stored in sinks or geological reservoirs. Other parts of the literature only consider biological sinks as carbon sequestration [90,p.1271].

[7] A sink is "any process, activity or mechanism that removes a greenhouse gas (…) from the atmosphere" [92].