



Exploring Narratives on Negative Emissions Technologies in the Post-Paris Era

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The 2015 Paris Agreement specified that the goal of international climate policy is to strengthen the global response to climate change by restricting the average global warming this century to “well below” 2°C above pre-industrial levels and to pursue efforts to limit it to 1.5°C. In this context, “Negative Emissions Technologies” (NETs)—technologies that remove additional greenhouse gases (GHGs) from the atmosphere—are receiving greater political attention. They are introduced as a backstop method for achieving temperature targets. A focal point in the discussions on NETs are the emission and mitigation pathways assessed by the Intergovernmental Panel on Climate Change (IPCC). Drawing on perspectives from Science & Technology Studies (STS) and discourse analysis, the paper explores the emergence of narratives about NETs and reconstructs how the treatment of NETs within IPCC assessments became politicized terrain of configuration for essentially conflicting interests concerning long-term developments in the post-Paris regime. NETs are—critics claim—not the silver bullet solution to finally fix the climate, they are a Trojan horse; serving to delay decarbonization efforts by offering apparent climate solutions that allow GHGs emissions to continue and foster misplaced hope in future GHG removal technologies. In order to explore the emerging controversies, we conduct a literature review to identify NETs narratives in the scientific literature. Based on this, we reevaluate expert interviews to reconstruct narratives emerging from German environmental non-governmental organizations (eNGOs). We find a spectrum of narratives on NETs in the literature review and the eNGO interviews. The most prominent stories within this spectrum frame NETs either as a moral hazard or as a matter of necessity to achieve temperature targets.

Keywords: negative emissions technologies, carbon dioxide removal, environmental NGO, IPCC, climate politics and policy, future making, narratives

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INTRODUCTION: SETTING THE STAGE FOR ANTICIPATING CLIMATE FUTURES

Narratives play a central role in mobilizing knowledge for climate action (e.g., Hulme, 2008; Jackson, 2015). Recently, Hajer and Pelzer (2018, p. 222) argue that narratives have become even more important as climate “politics is no longer about raising awareness but about shaping the sustainability transition itself.” More specifically, they indicate that “desirable climate futures” cannot be persuasively represented only in scientific terms of “CO₂ levels,” “parts per million” or in sole reliance on integrated assessment models (IAMs). While scientific evidence provided by

authoritative institutions such as the IPCC is an important resource for justifying and enacting climate politics (Beck and Oomen, 2021), scientific evidence alone does not seem sufficient to catalyze political action to meet the climate policy goals.

Narratives are understood as stories that define a problem, elaborate its consequences, and outline solutions (Roe, 1991; Leach et al., 2010). They play an important role as they can translate *matters of fact*—such as projected temperature—into *matters of concern* (Latour, 2004; Krauß and Bremer, 2020) because they spell out what futures are desirable (to what end) and what policy option are feasible and legitimate to achieve them. As climate politics shifts toward sustainability transformations, such narratives of desirable futures and ways to achieve them become more important in motivating and catalyzing political action on the ground (Hajer and Pelzer, 2018, p. 222). Following this line of argument, we explore emerging narratives around so-called Negative Emissions Technologies (NETs)—technologies, such as afforestation, bio-energy and carbon capture and storage or enhanced weathering, that remove CO₂ from the atmosphere—and how they are enacted in climate discourses.

The paper seeks to illuminate how the study of narratives can open up a fruitful discussion on desirable futures in a post-Paris era. While there is an emerging social scientific literature on IAMs and IPCC pathways (e.g., van Beek et al., 2020), there is a lack of empirical studies on how narratives are mobilized and challenged by environmental non-governmental organizations (eNGOs) on the ground (Oomen et al., 2021). To address this gap in the literature, we explore how the treatment of NETs within recent IPCC assessments and reports turned into a politicized terrain of configuration for essentially conflicting interests concerning long-term developments in the post-Paris regime.

We draw on perspectives from Science & Technology Studies (STS) and discourse analysis to explore the emerging narratives on NETs and gain first insights into their role in enacting climate politics. We conduct a review to reconstruct NETs narratives identified in the scientific literature. Additionally, we reanalyze expert interviews with eNGOs to explore how they respond to the role of NETs in IPCC reports. We focus on how NETs are embedded in narratives of desirable futures and study how they are justified.

The paper is structured as follows. The next section illustrates the conceptual framework and introduces an understanding of narratives from a co-productionist perspective. Data and Methods section gives a detailed account of the methods used in our analysis. We present the results of the literature review and the secondary analysis of the expert interviews in Role of NETs in Climate Governance—Insights From the Scholarly Literature and German eNGO narratives on NETs sections. Discussion section discusses the results in light of previous investigations and marks out promising avenues for further research.

CONCEPTUAL FRAMEWORK

In this section, we will introduce the conceptual framework of this study by defining narratives and addressing their role in climate governance from a co-productionist viewpoint (see also Longhurst and Chilvers, 2019). Furthermore, we introduce research on climate policy discourses (Bäckstrand and Lövbrand, 2019) as a reference point for our analysis of NETs narratives.

There are many different ways of characterizing and analyzing narratives (e.g., Abbott, 2008; Cobley, 2014; Amerian and Jofi, 2015). Bremer et al. (2017, p. 671) summarize narratives as follows: “narratives set a sequence and order to events occurring in a defined place and time, often structured as beginning–middle–end.” More specifically, we consider narratives as stories that define a problem (beginning), elaborate on its consequences (middle) and outline solutions (end) (Roe, 1991; Leach et al., 2010). Similarly, Felt et al. (2007, p. 73) note, narratives “define the horizons of possible and acceptable action, project and impose classifications, distinguish issues from non-issues, actors from non-actors.” Concerning climate policy, narratives influence the way societal groups and actors understand the problem and have a strong impact on how solutions are perceived, communicated, and legitimated. Thus, they play an important role in assembling and integrating actors around a particular kind of vision of desirable futures (cf. Hajer and Pelzer, 2018; Longhurst and Chilvers, 2019, p. 975).

Our understanding of narratives is rooted in a co-productionist perspective, which is based on the assumption that there are intrinsic links between ways of knowing a phenomenon on the one hand, and ways of acting upon it to transform it on the other (Jasanoff, 2004; Longhurst and Chilvers, 2019). This approach offers an interpretive lens to explore underlying normative, but often hidden rationales and justifications of policy choices for governing emerging technologies and distributing their risks and benefits (Beck et al., 2021). From a co-productionist perspective, even narratives of plausible futures that are seemingly descriptive or exploratory (such as the IPCC pathways), are prescriptive in that they put forward particular visions of what counts as a desirable future (Andersson and Westholm, 2019).

To contextualize the discussion on NETs narratives in climate politics, we draw on Bäckstrand and Lövbrand (2006, 2019) classification of climate policy discourses. In line with Hajer (1995, p. 45), they understand discourses as “specific ensembles of ideas, concepts and categorization that are produced, reproduced and transformed in a particular set of practices.” Climate policy discourses and their role in climate governance are conceptualized as follows: “By defining problems of government, determining desirable codes of conduct and canvassing areas of political intervention, they produce the governed reality and hereby delimit the realm of the possible for climate politics” (Bäckstrand and Lövbrand, 2019, p. 520). In order to relate climate policy discourses and narratives, we understand narratives as embedded in discourses and emerging in discursive practices (cf. Urhammer and Røpke, 2013). Narratives are one mode of sense making within discourses. They draw upon

different discursive elements in order to connect to preceding discussions and organize them into comprehensible plots. For the case at hand, we follow the rationale that narratives on NETs emerge as part of climate policy discourses. This enables us to relate the definitions of problems and solutions in NETs narratives to those outlined in climate policy discourses.

Bäckstrand and Lövbrand identify three climate policy discourses in forest plantation projects: ecological modernization, green governmentality and civic environmentalism (Bäckstrand and Lövbrand, 2006, p. 52 et sqq.).

- The **ecological modernist discourse** combines cost-efficient climate mitigation with sustainable forest management in a “win-win rhetoric.” From this point of view climate change can be solved by technological innovation and markets.
- The **green governmentality discourse** stresses planetary carbon control by scientific precision (highlighting, amongst others, the IPCC report on IPCC (2000a) and “professionalized resource management, environmental target-setting and monitoring” (Bäckstrand and Lövbrand, 2019, p. 523).
- In contrast to the other discourses, the heterogeneous and critical **civic environmentalism** discourse moves beyond global markets and standardized science and top-down management in favor of local, bottom-up participation in forest sequestration projects. From this perspective climate change requires fundamental transformations of consumption patterns and institutions.

More than a decade later, Bäckstrand and Lövbrand (2019) return to their typology of policy discourses and examine to what extent they still shape climate politics. They consider the UN climate conferences in Durban (2011), Warsaw (2013), Lima (2014), and Paris (2015) as “active political sites where particular ways of thinking about and acting upon climate change take form, stabilize and enable more or less systematic forms of government” (Bäckstrand and Lövbrand, 2019, p. 521). While there are some “subtle shifts in the discursive landscape,” the overall framework of Bäckstrand and Lövbrand has proven to be helpful for mapping climate discourses on the international level over time (Bäckstrand and Lövbrand, 2019, p. 528).

We will employ this framework in our analysis by discussing how the identified narratives relate to the three historically established climate policy discourses. This enables us to distinguish between novel emerging narratives on NETs. It, also allows for future comparisons of narratives on other climate related technology or policy issues.

DATA AND METHODS

In this section, we provide information on methods used for our exploration of NETs narratives. We combine literature reviews and secondary analysis of interviews with eNGO experts in order to reconstruct emerging NETs narratives. This approach enables us to explore the range of NETs narratives and to gain insights into ongoing controversies by paying particular attention to the perspectives of eNGOs.

Literature Review

We conducted a topic search in the journal database Web of Science to identify relevant literature for our review (see **Table 1**). The focus of the literature review is to better understand narratives on the governance of NETs that either build on or differ from the role of NETs in pathways presented by the IPCC, especially the Special Report on 1.5°C global warming (from now on IPCC SR15). Given that this is still a nascent field of research, we adopted a broad approach to gathering relevant literature, using two search strands targeting two mutually overlapping bodies of literature. We complemented this formalized approach by identifying additional literature from, for instance, reference lists and quotations.

We used a total of five keyword groups (search strings). For the two search strands, we combined a total of four keyword groups (**Table 1**). Three keyword groups (1–3) were the same in each search strand. We designed keyword groups 1–3 to capture papers that deal with a post-Paris world (1), ways of knowing or imagining the future (e.g., scenarios) (2), and ways of governing (3), respectively. In addition to these three keyword groups, we added one keyword group focusing on the IPCC (4), and another one focusing on NETs (5). To form our two search strands, we then combined keyword groups 1–4 for the first one, and 1–3 plus 5 for the second one. We chose to focus on these keyword groups and search strands as they are apt to provide articles that develop NETs narratives (for instance by legitimizing NETs as promising climate change mitigation option).

We designed the keyword groups to capture a broad range of papers and one by one, these keyword groups generate a very large number of papers, but combined, they generate a more manageable and targeted batch of papers. The aspiration was not to cover all literature. The aim of this search approach was instead to (1) present a transparent strategy that can be extended, and (2) inductively examine the available literature that falls within our inclusion criteria.

The two search strands generated a total of 102 papers after removing duplicates. All abstracts were screened and 47 papers selected for full review. The main reasons for excluding papers based on the screening of abstracts were: (1) the paper did not focus on politics, governance or the like but on rather technical and scientific issues outside the scope of the current paper, (2) the paper engaged with ways of knowing the future rather than governing the future. In cases of doubt regarding relevance, the paper was included in the full paper screening.

We reviewed the literature for recurring themes and analyzed how NETs are represented as a climate change mitigation option. We paid particular attention to the problems (e.g., average global temperature rise, delaying decarbonisation) and solutions (e.g., the deployment of NETs) and how they are justified.

Expert Interviews

We conducted a secondary analysis of seven semi-structured expert interviews with German environmental NGO representatives to complement the literature review and to

TABLE 1 | Sampling steps literature review.

Search in web of science		Results
Language: English Time span: 2015–2020 Results from all databases Topic Search		
Keyword groups		
#1: (Paris Agreement OR post-Paris OR "COP 21" OR COP21 OR "conference of the parties")	AND	#4: (IPCC OR "Intergovernmental Panel on Climate Change")
AND		#5: ("carbon dioxide removal" OR "negative emission" OR "bioenergy with carbon capture" OR "direct air capture" OR afforestation OR reforestation OR "blue carbon" OR "ocean fertilization" OR "ocean alkalinity" OR "enhanced weathering" OR "soil carbon sequestration")
#2: (imaginary OR future OR narrative OR discourse OR storyline OR pathway OR scenario)		
AND		
#3: (governance OR policy OR policies OR political)		
Total		110
After merging duplicates		102
After content screening		47

We used "*" as truncation operator to capture variations of a word e.g., govern* where appropriate.

reconstruct emerging narratives on NETs. We chose these interviews for a secondary analysis of NETs narratives as each of them featured extensive discussions on the role of NETs in climate change mitigation. The interviews thus provide a valuable basis for this exploratory analysis of the narratives emerging around NETs in the German eNGO community.

The interviews were carried out in two different research projects and at different times. Four face-to-face interviews took place in 2018, shortly after the publication of IPCC SR15 (2018). They focused on the role of climate engineering including CDR in scientific assessments. A second batch of three interviews was conducted in 2020. The main concern of these interviews was the perceptions of carbon capture and storage technologies (CCS).

Both research projects followed a parallel sampling strategy to select interview partners. Environmental NGOs were defined in reference to the UNFCCC list of admitted NGOs (UNFCCC, 2021), and we considered those that are listed as part of the "environmental CAN" (climate action network) constituency as relevant for our purposes. A two-step theoretical sampling strategy was applied (Glaser and Strauss, 1970; Dimbath et al., 2018). We selected eNGOs from the UNFCCC list in order to capture the perspectives of the main actors of the German eNGO field (Foljanty-Jost, 2005), and according to an initial analysis of eNGO position papers on NETs. In a second step, we identified and approached specific interview partners based on their thematic work (energy and/or climate policy) within the eNGO. In order to ensure confidentiality and enable an open interview atmosphere, we agreed to keep the institutions and interview partners anonymous. While there is an overlap between the eNGOs interviewed in the two projects, we did not interview the same representatives twice. All interviews were recorded and transcribed.

We employed qualitative content analysis (Schreier, 2012) to code the interviews and to identify NETs narratives. We developed a coding frame to collect all segments of the interviews concerning NETs. These sections were analyzed for narratives

that justify, assess or contest the climate change mitigation potential of NETs.

ROLE OF NETs IN CLIMATE GOVERNANCE—INSIGHTS FROM THE SCHOLARLY LITERATURE

In this section, we review the state of research and identify narratives around the role of NETs in climate policy. We conclude the section by drawing linkages between the narratives we outline and broader climate policy discourses (Bäckstrand and Lövbrand, 2019).

NETs Narratives in Climate Policy—A Spectrum of Ideas

Carbon sinks—understood as "natural or man-made systems that absorb CO₂ from the atmosphere and store them" (IPCC, 2000b)—feature in the IPCC assessments since the early 1990s (e.g., IPCC, 1990, p. 12), and have been a part of the UNFCCC since its inception (United Nations, 1992). The large scale removal of additional CO₂ from the atmosphere has more recently gained attention as component of climate change mitigation pathways (cf. Carton et al., 2020, p. 2). In its fifth assessment cycle, the IPCC introduced bioenergy with carbon capture and storage (BECCS) as a mitigation option aimed at keeping global warming below 2°C (IPCC, 2014, p. 89). SR15 clearly states: "All pathways that limit global warming to 1.5°C with limited or no overshoot project the use of carbon dioxide removal (CDR) on the order of 100–1000 GtCO₂ over the twenty-first century. CDR would be used to compensate for residual emissions and, in most cases, achieve net negative emissions to return global warming to 1.5°C following a peak" (IPCC, 2018, p. 17).

Recent IPCC assessments have been widely interpreted in the scholarly literature to show that the global temperature goals cannot be met without NETs (Lin, 2018; Minx et al., 2018; Rogelj et al., 2018; Stavrakas et al., 2018; Doelman et al., 2019;

Fajardy et al., 2019; Mundaca et al., 2019; Rickels et al., 2019; Honegger et al., 2020). In other words, **NETs are framed as a matter of necessity** (solution) to reach the long-term global temperature goal (problem) (see United Nations, 2015). They are taken as an integrative part of climate governance. Bellamy and Healey (2018, p. 1) state: “It is increasingly recognized that meeting the obligations set out in the Paris Agreement on climate change will not be physically possible without deploying large-scale techniques for either removing greenhouse gases already in the atmosphere or reflecting sunlight away from the Earth.”

A recurring argument against the inclusion of NETs in emission and mitigation pathways is that NETs risk slowing down mitigation action today, leaving unanswered the important question of what happens if NETs do not deliver at scale (e.g., Larkin et al., 2018; Carton, 2019; Waller et al., 2020). This is also known as mitigation deterrence or, as we will call it henceforth, **moral hazard** (e.g., Low and Schäfer, 2020; McLaren, 2020). In this narrative, NETs are not framed as a solution to the problem of achieving temperature targets rather they risk distracting vital attention from mitigation efforts.

In the literature reviewed, the narrative that NETs are necessary to reach temperature targets relates to other narratives about the role of NETs in climate policy. Some present NETs as unwanted but without alternatives (Haikola et al., 2019), others specific NETs as options to optimize climate mitigation (see e.g., Herr et al., 2017 on Blue Carbon; Marcucci et al., 2017 on direct air capture with CCS; Fernandez and Daigneault, 2020 on afforestation). Consequently, these narratives form a spectrum, ranging from NETs as a feasible and effective option to reach temperature targets, through NETs as necessary option to reach temperature targets (but not necessarily positive), to NETs as a risky option for reaching temperature targets. To better understand the differences and overlaps between these narratives, we now explore their overarching rationales related to climate policy, and associated risks.

Exploring the Rationales Underpinning NETs’ Narratives

In the “**NETs are necessary**” narrative, the rationale for the deployment of NETs is to reach the long-term global temperature goals. NETs take time, the argument goes, to develop. Hence, if we want them to deliver as assumed in the pathways, we need to act now in terms of, for instance, research funding and institutional compatibility (Minx et al., 2017; e.g., Bataille et al., 2018; Bellamy and Healey, 2018; Nemet et al., 2018; Stavrakas et al., 2018; Brack and King, 2020; Jones and Albanito, 2020). It is generally acknowledged that there are uncertainties regarding the large-scale deployment of NETs (e.g., IPCC, 2018). However, without NETs, the chances of reaching the long-term global goal are even lower (e.g., Lin, 2018; Daggash and Mac Dowell, 2019; Haikola et al., 2019).

In contrast, a main concern for the narrative that portrays **NETs as a moral hazard** is that including NETs in pathways

and strategies changes political priorities today in ways that affect possibilities in the future (cf. Low and Honegger, 2020; Woroniecki et al., 2020). In this case, the promise of capturing and removing carbon in the future is delaying action today (e.g., Shue, 2018; Asayama and Hulme, 2019). As phrased by Carton (2019, p. 765): “The political economy of delay, a constellation of economic, political, cultural and everyday practices that in numerous ways serve to postpone the necessary devaluation of fixed fossil fuel capital.” Moreover, even though uncertainties around large-scale deployment of NETs are clearly outlined in the literature (e.g., IPCC, 2018), the fact that NETs are nevertheless included in pathways could lead actors to take their effectivity for granted and make it difficult to understand the urgency to act on climate change today (e.g., Larkin et al., 2018).

The concern that the promise of NETs could slow down mitigation action is partly addressed in the literature where the role of NETs is seen as necessary. The essential contribution of NETs is to compensate for hard-to-abate emissions—for instance from aviation or shipping (e.g., IPCC, 2018; Minx et al., 2018). In other words, NETs should complement other efforts, not be the only game in town. In the scholarly literature, there are numerous examples for combining rapid societal change with future technological solutions such as the use of NETs (Grigoroudis et al., 2017; Marcucci et al., 2017; Aengenheyster et al., 2018; Brack and King, 2020).

Reducing Uncertainties and Exploring Alternative Approaches

One key concern that emerges from the scholarly literature related to governance of NETs is the uncertainties of the future, large-scale deployment. There seem to be two main suggestions on how to address these uncertainties in the literature. Following the **NETs are necessary narrative**, the main focus is on reducing uncertainties, not least by providing more resources to research and development (e.g., Nemet et al., 2018; cf. Low and Honegger, 2020). They are based on the rationale that uncertainties are manageable by more and better research.

There is also a strand of literature that focuses on assessing uncertainties regarding the feasibility of NETs deployment that, instead of looking at the feasibility of reaching specific temperature targets, starts with today’s conditions and asks what seems feasible, given current conditions (cf. Thoni et al., 2020). These types of analyses often break down ideas of maximum potential to more modest expectations for the use of NETs (Boysen et al., 2017; Geden et al., 2018; Vaughan et al., 2018; Asayama and Hulme, 2019; Wachsmuth and Duscha, 2019; Brack and King, 2020; Wieding et al., 2020). As such, this literature can be understood as an attempt to address the risk of mitigation deterrence by taking current conditions rather than distant goals and theoretical possibilities as a starting point. For instance, as phrased by Geden et al. (2018, p. 1): “While policymakers, in accepting the IPCC’s assessments, appear to have implicitly accepted that CDR is necessary to meet the Paris Agreement’s targets, they have avoided asking (or answering) the next obvious question: ‘Who exactly is going to do it?’”

Following the **moral hazard narrative**, the focus is instead on exploring alternative ways of imagining the future than modeling in general and IAMs specifically. Opening up the imagination of climate futures does not reduce uncertainties related to the deployment of NETs as such, but reduces the risk that the political imaginary is reduced to a narrow spectrum (Beck and Mahony, 2018; Beck and Oomen, 2021).

There is a growing body of literature that argues to the importance of creating spaces in which a broader range of actors (not just experts and government representatives) are given the opportunity and the means to imagine climate futures (Lawrence et al., 2018; Forster et al., 2020; Low and Honegger, 2020; Markusson et al., 2020). One aim of broadening the debate is to ensure that political and normative choices do not remain hidden in technical practices such as IAM scenarios and to ensure that a range of futures can be explored rather than just a narrow set of pathways (e.g., Beck and Oomen, 2021). For example, in their analysis of views on and ways of assessing the feasibility of NETs deployment, Forster et al. (2020) highlight a range of existing approaches that could complement IAMs by attending to complex socio-political issues, including future options beyond those explored by IAMs. Examples include participatory integrated assessments, transparent communication around assumptions, and responsible and reflexive assessment, innovation, and governance (Forster et al., 2020; see also Beck and Mahony, 2017; Berg and Lidskog, 2018).

Link to Climate Governance Discourses

In our review, we identified two important narratives on the role of NETs in climate policy - one proposing that the deployment of NETs will be necessary and thus should be considered a part of climate governance to reach temperature targets, and another one suggesting that including NETs as part of climate governance can lead to mitigation deterrence and make it more difficult to mitigate climate change. We also saw alternatives or hybrids, such as focusing on feasibility of deployment on the ground rather than feasibility of meeting temperature targets, less easily placed in either one of these narratives. Hence, while there are clearly deep differences between the key narratives we have identified, the scholarly literature on NETs cannot only be understood as a rigid dichotomy between these two narratives. It is probably more accurate to think of the literature as representing a spectrum of findings and arguments that are deeply supportive of NETs deployment, necessary or not, to deeply against it. To better understand the differences and similarities between the two main narratives discussed in this section and to place them in a broader context, we now turn to the literature on climate policy discourse, more specifically the discourses of green governmentality, ecological modernization, and civic environmentalism (Bäckstrand and Lövbrand, 2006, 2019).

The discussion about NETs in general carries important characteristics both from green governmentality such as the focus on staying below a global temperature target, and the idea about carbon sinks (see e.g., Carton et al., 2020) and

ecological modernization with technological solutions, win-win between climate action and economic development, and cost efficiency (Fujimori et al., 2018; Honegger and Reiner, 2018; Ueckerdt et al., 2019; Donnison et al., 2020). Previous literature has also suggested that ideals associated with the ecological modernization discourse, such as techno-fixes and market solutions, could, in the context of NETs, slow-down the phasing out of “carbon infrastructures” (cf. Low and Boettcher, 2020, p. 9), in line with the moral hazard narrative. In terms of mobilization of actors, a recurring theme in the literature on NETs is the role of science and expertise, as well as large bodies like the IPCC (see e.g., van Beek et al., 2020; Waller et al., 2020). To address the risk of NETs as a moral hazard and the closing down of alternative climate futures, scholars have suggested the need to open up the process of knowledge-making (e.g., more disciplines) and decision-making, especially related to marginalized groups and intergenerational justice, a theme in line with the civic environmentalism discourse (cf. Carton, 2019; Carton et al., 2020; Markusson et al., 2020; Paterson, 2020).

Comparing rationales behind NETs as a climate policy option, we see that in general, literature on NETs commonly highlights the urgency of climate change as a global problem, which is typically associated with the green governmentality discourse (Bäckstrand and Lövbrand, 2019), and the need for rapid emission reductions combined with the deployment of NETs (Grigoroudis et al., 2017; Marcucci et al., 2017; Aengenheyster et al., 2018; Rogelj et al., 2018; Brack and King, 2020). However, assuming large-scale future deployment of NETs could provide justifications for incremental change and slower decarbonisation, as cautioned by the moral hazard narrative (cf. Holz et al., 2018; Butnar et al., 2020). Consequently, taking into account the risk that NETs are not deployed at large scale in the future means that even more rapid transformation is needed (Larkin et al., 2018; Lawrence et al., 2018; Asayama and Hulme, 2019; Harwatt, 2019; Anderson et al., 2020; Wieding et al., 2020) is more in line with the civic environmentalism discourse. Hence, a key feature of NETs' narratives is that they outline ideas for change, but may differ in their understanding of the plausible and desirable pace and magnitude of change, partly corresponding with differences between the NETs are necessary and the moral hazard narratives (cf. Ueckerdt et al., 2019 about the “economically optimal warming limit” and NETs deployment; Larkin et al., 2018; see also Linnér and Wibeck, 2020).

That being said, the literature on NETs is not black and white in terms of links to overarching climate policy discourses. This becomes clear not least when considering individual NETs rather than all NETs as a group. Some NETs that focus on enhancement of natural sinks, including restoration of ecosystems, are sometimes called nature-based solutions. The literature on such technologies includes discursive elements that have clear links to ecological modernization, such as a win-win narrative, market-based approaches, and cost-efficiency (see e.g., Needelman et al., 2019; Pascoe et al., 2019; Carton et al., 2020; Fernandez and Daigneault, 2020). However, there are also some similarities to the civic environmentalist discourse, with a narrative around community-based, bottom-up approaches (e.g., Sutton-Grier and Moore, 2016; Herr et al., 2017).

GERMAN eNGO NARRATIVES ON NETs

NETs and carbon dioxide removal overall have not been prominent topics in German climate policy and they do not feature in the German climate law (Federal Law Gazette, 2019). With the IPCC SR15 carbon dioxide removal entered policy debates but it is approached with restraint (Schenuit et al., 2021). Especially NETs connected to CCS are discussed with much reluctance because of earlier public and political opposition against CCS projects and the persisting legal barriers for the deployment of this technology (e.g., Fischer, 2015; Dütschke et al., 2016; Krämer, 2018; see also Federal Law Gazette, 2012). As Schenuit et al. (2021) argue, this results, *inter alia*, in a differentiation into “natural” (e.g., afforestation) and “technical/geochemical-based” NETs (e.g., BECCS) in the German discussion. Recently, dynamics in German eNGO positions on NETs were observable. Some either expressed support for “natural” carbon removal (Deutscher Naturschutz Ring, 2020) or acknowledged the need for geochemical-based NETs (e.g., Wuppertal Institut für Klima, 2018; Prognos, 2020). To further investigate these dynamics we analyze expert interviews with German eNGO representatives.

We identify three different narratives with regard to a potential future role for NETs, each engaging with NETs in a different way. Two of these narratives map on the most prominent stories we found in our literature review and resemble the moral hazard and NETs are necessary narratives. In addition, we find a variation of the NETs are necessary story that centers on the thought that NETs are unwanted but seemingly unavoidable. Our aim in describing the narratives is to add to the stories outlined in the literature review and the literature on eNGO perception of NETs (e.g., Corry and Riesch, 2012; Corry and Reiner, 2020). In addition, we discuss how the IPCC is called upon as a resource of legitimation for these narratives.

NETs as a Moral Hazard

NETs as a moral hazard was the dominant narrative in the first set of expert interviews in 2018 and recurs in the second set conducted in 2020. It rejects NETs completely as a technical means of offsetting emissions. “End-of-pipe” technologies such as carbon capture and storage (CCS) and NETs connected to CCS (like BECCS or direct air carbon capture and storage - DACCS) are not regarded as viable options for achieving climate targets. On the contrary, they are considered as moral hazard for the following two rationals:

1. They distract from CO₂ reduction efforts in the present by promising the extraction of atmospheric CO₂ in the future by “wishful thinking” and “science fiction.” Betting on NETs is neither economic nor realistic. DACCS especially is perceived as inefficient because of the low concentration of CO₂ in the atmosphere and the high amount of energy it would take to capture, transport and store it. Hence, avoiding emissions from the start is much more useful while efforts expended on NETs are a “waste of time” that could be spent on more pressing issues.

2. Especially those NETs connected to the geological storage of CO₂ entail risks. Framed as “waste disposal,” CCS is seen as a “risk technology” due to the uncertainties arising from potential leakages, migration of the CO₂ plume or induced seismic activity. Beyond the risks of geological storage, environmental concerns are raised for BECCS on account of the “excessive land use” required for biomass production, resulting in biodiversity loss (due to monocultural biomass plantations) and negative impacts on natural CO₂ sinks (e.g. deforestation to extend agricultural land).

In this sense, the moral hazard narrative identified in the eNGO interviews positions NETs as a problem for climate change mitigation and strongly critiques any reliance on CCS based NETs. Following this line of argument, some interviewees raised the question why ambitious temperature goals are maintained if they are not achievable without NETs. Other eNGO representatives questioned the inclusion of BECCS in IPCC assessments. Despite their vocal criticism of NETs, however, the interviewees were careful in raising concerns about the IPCC, as the following statement illustrates:

“I have doubts about the process [of drafting the IPCC SR15]. I have named [energy company] before as a substantial supporter of CCS technology in Germany. It really raises questions about the independence of research, when [an energy company] sponsors a professorship for sustainability and this professor, who is an advocate of CCS, arouses false hope and is involved in the writing of the IPCC report. While I hold the IPCC in high, high esteem I am critical of the process [that led to the inclusion of large amounts of BECCS in the scenarios].”

External influence—namely company lobbying—is viewed to have a negative impact on the IPCCs assessment and as responsible for the inclusion of BECCS.

In this narrative, that rejects NETs completely, all efforts for climate change mitigation should focus on the expansion of renewable energy production, the reduction of overall energy consumption and behavioral changes (e.g., mobility). If there should still be a future need for negative emissions, this should be addressed by strengthening natural carbon sinks (e.g., rewetting of peatlands or eco-system restoration) and “revitalizing the environment” in the process.

NETs Are Unwanted but Seemingly Unavoidable

This second narrative seeks to adopt a “realistic position,” as one of the interviewees put it, by engaging in a differentiated discussion of NETs. This position still prioritizes energy system transformation and behavioral change for sustainability, but centers much more on the question of what kind of NETs might play a role in the future, not whether NETs should play a role at all. The interviewees refer to the IPCC in order to make the case that presumably some form of NETs will be necessary in the future. They stress that the IPCC makes the trade-off between NETs and emissions reduction explicit as the scale of NETs will heavily depend on the amount of emissions cut. A reliance on NETs is still unwanted and everything should be

done to avoid the need for such measures. Parallel to the first narrative, the feasibility of BECCS is called into question due to the “unrealistic” amount of land that would be required for the production of biomass to achieve the bioenergy estimated in the IPCC pathways in SR15. The inefficiency and high costs associated with DACCS are raised as barriers to deployment, and the safety issues of geological CO₂ storage (intrusion into groundwater, plume movement) are pointed out. It is not possible, however, to dismiss NETs altogether, as a sufficient reduction of greenhouse gas emissions might not be achieved in time. This conflictual position becomes apparent in the following statement:

“But it is also clear to me that, if we seriously consider the Paris climate goals and simultaneously do not move away from the path on which we are moving now, that of course things like direct air capture will be necessary. But I don’t know how. And right now I don’t see the time to focus on that, but rather to initiate the transformation while we still can. Direct air capture is perhaps for the time when we know for sure: we are too late and cannot change it anymore.”

If the removal of CO₂ becomes unavoidable then “nature-based solutions” (rewetting peatland, soil carbon sequestration, and afforestation) are favored in this narrative because of their beneficial effects on nature conservation, even if the problems associated with such solutions—including the international coordination of measures and the scale and security of CO₂ storage—are apparent. The interviewees who mobilize this narrative are “hopeful” given that not all the IPCC’s pathway scenarios include a high amount of NETs based on CCS; they state their support for “those pathways without or with limited BECCS [in IPCC SR15].” This establishes a link to the IPCC scenarios and an option to highlight the aspects of the report that fit the narrative while still being critical of others. Their strongest criticism is directed at the “enormous” amounts of BECCS in some scenarios.

NETs Are Necessary

This narrative became apparent in the second set of interviews conducted in 2020. It states clearly that, in the interviewee’s opinion, the IPCC has shown that NETs will be necessary to achieve net zero carbon emissions and there is no way around them. This is taken as the “word of science” on the “goal of climate neutrality.” It is, therefore, crucial to have climate models that “really calculate climate neutrality” and outline the capacity of NETs needed to achieve it. A “100 percent renewables” approach does not appear feasible in the light of the scenarios and is incompatible with the Paris temperature goals and the net zero target. In consequence, the interviewee who mobilizes this narrative is puzzled by the debate on BECCS:

“I see the goals for climate neutrality, for the CO₂ budgets. I take them as the word of science and the same scientific report names BECCS. And should I now say I reject BECCS? For me this is one paper and if its first core message is—the CO₂ budget is this—and its second message is—BECCS potential is this—then I cannot take the one and ignore the other. That would be unscientific.”

The selective reception of scientific assessments might be done with political intention but, in the interviewee’s opinion, this is not “science-based” and the IPCC report needs to be “appreciated in its entirety.” A rapid transformation of the energy system and of society as a whole toward sustainability still has the highest priority, but if negative emissions are an inevitable addition, then it is “unproductive and potentially damaging” to view natural and technical carbon removal as competing with each other. “All peatlands and all rainforests will be necessary to reach net zero and technical sinks will still be required as well.”

Considering the diversity of narratives around NETs, our results are in line with previous studies of eNGO positions on NETs and CDR (Corry and Reiner, 2020), which also found competing evaluations of the issue. Comparing the eNGO narratives to the spectrum of stories we found in the literature review, we see that the narratives 1 and 3 fit the moral hazard and NETs are necessary narratives. The second eNGO narrative can be seen as a variation of the NETs are necessary narrative. It acknowledges that some NETs will most likely be needed to achieve temperature targets but emphasizes the strong preference for a rapid reduction of carbon emissions.

We see that the prominent role of NETs in IPCC assessed pathways is controversial among German eNGOs. Consequently, references to the IPCC (most prominently to SR15) may express various attitudes (approval, rejection, building upon etc.). For eNGOs that oppose NETs this can mean questioning the IPCC on the grounds of influence exerted by industry or politicians, unrealistic assumptions, or the selectivity of the scientific literature assessed (e.g., dominance of IAMs). Those who see NETs as “unwanted but seemingly unavoidable” may stress the existence of scenarios without or with small amounts of BECCS in the IPCC assessment and point to “nature-based solutions” to achieve negative emissions. Those who see NETs as necessary draw on the IPCC report and accuse other eNGO views of being selective by neglecting NETs.

When we relate the narratives to the climate policy discourses discussed by Bäckstrand and Lövbrand (2019), it is not possible to pinpoint the narratives in one particular discourse. While we find that the first narrative, NETs as moral hazard, can be conceptualized as part of the civic environmentalism discourse (as it advocates fundamental transformations instead of future NETs), it also contains some of the logic of an ecological modernization discourse and green governmentality in its discussion of natural sinks for carbon removal. The third narrative might stress the need for NETs in an ecological modernist fashion but it also contains elements of civic environmentalist discourse, with a strong emphasis on the necessity of combining all available climate change mitigation options and the need for “fundamental transformations of our consumption patterns and institutions” (Bäckstrand and Lövbrand, 2006, p. 56). The second narrative (NETs are unwanted but seemingly unavoidable) is positioned between the ecological modernization and civic environmentalism discourses and displays characteristics of both. With their strong reliance on the authoritative role of “big science” and “scientific expert advisors” (such as the IPCC) in the construction of eco-knowledges along with the shared idea that “sound science” is a

legitimate resource with which to measure, predict and manage environmental risks (cf. Bäckstrand and Lövbrand, 2006), we find elements of a green governmentality discourse ingrained in all three eNGO narratives. Thus, rather than attributing eNGO narratives on NETs to clear-cut positions in climate policy discourses, we find that the lines between discourses blur in discussions on the necessity of NETs.

Taking a closer look at the interpretational power ascribed to the IPCC by the interviewees, we find that there is a general agreement on its position within the climate change discourse. All interviewees stress the relevance of the IPCC and perceive it as a “political actor” and a “global reference” with epistemic authority on issues of sustainability and climate change. IPCC reports are described as “political initiators” for sustainability and even “vehicles for enhancing political pressure.” The narratives we have identified in this exploratory study all relate to the IPCC’s conclusions around NETs, suggesting that eNGOs are currently confronted with a situation where IPCC reports can be referred to by various actors to either legitimize or delegitimize proposals for NETs. It will be a task for future studies to investigate this further.

In addition to referring to the IPCC in a certain fashion, the eNGO narratives on NETs display further characteristics we wish to point out. The first of these is a positivist perception of science that is embedded within the narratives. This is most apparent in the third narrative where scientific evidence (“the word of science”) is the main argument for a climate future with NETs while diverging narratives are accused of not “appreciating” the IPCC report in its entirety and not being “science based” but “political.” To a lesser degree, this also holds true for the second narrative, in which the existence of a scenario without BECCS or DACCS is seen as providing “hope” for a positive climate future. Even though the IPCC is criticized in the first narrative for including large amounts of BECCS, this critique is ultimately directed either at an external actor—namely, an energy company illegitimately advocating CCS—or at organizational issues rather than at the scientific procedures. Corry and Reiner (2020) note a similar emphasis on “the science” and “truth” in recent climate protests. This perception of science portrays a narrowed down version of the relation between scientific expertise and political processes, with the former guiding the latter.

A second characteristic of the narratives is their positioning of actors within the stories. So far, we have discussed the representation of the IPCC as a scientific authority, but other actors are also mobilized in them. One example of this are energy companies. They appear in the narratives as adversaries and represent a counter-position to the eNGOs. In the moral hazard narrative this becomes clear when a push for NETs and a negative influence on the IPCC are identified as stemming from an energy company “meddling” in scientific research. Technologies like BECCS and “nature-based solutions” are also mobilized in the narratives. These technologies are, depending on the narrative, either represented as opposition or alliance—“villains” or “heroes” of desirable futures. Such dichotomies reduce the complexity of these carbon removal options and obscure what counts as a “nature-based solution”—lost in the simplification are the paradoxes and unintended consequences (e.g., Bellamy and Osaka, 2020; Bertram and Merk, 2020; Woroniecki et al., 2020).

DISCUSSION

Our study begins with the search for NETs narratives and the question how the IPCC’s assessments of NETs turned into a terrain of configuration for essentially conflicting interests. In an explorative approach, we reconstruct emerging NETs narratives in the scientific literature and in a secondary analysis of expert interviews with environmental NGO representatives.

We find a spectrum of narratives in the literature review, ranging from the view that NETs can play a positive role to achieve climate targets, to the perspective that there is a risk that NETs delay climate action. Our analysis identified two especially prominent narratives. The first falls in the middle of the outlined spectrum and frames NETs as a matter of necessity by building upon IPCC assessments. The second positions NETs as a moral hazard because they delay decarbonization and their feasibility is uncertain.

In a new phase of climate politics, eNGOs have to respond to the novel role of the IPCC as venue for anticipating sustainability transformations (e.g., Beck and Mahony, 2018; Hajer and Pelzer, 2018). Our findings indicate that the inclusion of NETs into the climate portfolio results into controversies among eNGOs and, like in the literature review, we find a spectrum of positions on NET. We find the prominent “moral hazard” and “NETs are necessary” narratives but also some variation of the latter. This further stresses the point that these narratives should not be seen as a strict dichotomy since they do not account for all positions within the debate. In line with existing literature (e.g., Corry and Reiner, 2020), we find that eNGO representatives integrate the IPCC assessments into their argumentative positions on NETs in different ways. Those promoting NETs as a viable option for mitigating climate change count on the IPCC. Those more skeptical or averse to NETs mobilize alternative resources (for instance scenarios not included in IPCC reports) or focus on pathways with “nature based” NETs in the IPCC assessments in order to legitimize their narratives. We observe that those critical of NETs (and of the IPCC for including them in their assessments) are also reluctant to challenge the IPCC’s epistemic authority openly. The eNGOs in our small sample still seek a scientific legitimation for their narrative.

Our study contributes to a better understanding of the role of narratives: we show how different actors draw upon various elements to support their visions of desirable climate futures and to position themselves in responses to NETs and their potential or risks. “Nature-based solutions” offer a good example of this. In order to present these options as alternative to “high-tech” options such as BECCS or DACCS, eNGOs framed them as less invasive and in alignment with nature. In agreement with previous studies (e.g., Woroniecki et al., 2020), we argue that this does not only rely on assumptions taken for granted about “nature” but that it neglects the complexities and entanglements of so-called “nature-based solutions” in their natural and societal contexts. It would be worthwhile to study the rhetoric and metaphors of this debate in more detail in future research (Corry and Riesch, 2012, p. 92; see for instance, Castree, 2020).

The prevailing NETs and alternative narratives can be connected to the climate discourses identified by Bäckstrand

and Lövbrand (2019). Their framework is helpful for analyzing conflicting lines of argument in the field of climate politics emerging around NETs. We find that the “NETs are necessary” narrative is partly linked to the discourse on ecological modernization with its technological focus and emphasis on eco-friendly capitalism. For the moral hazards narrative, we find linkages with civic environmentalism (Bäckstrand and Lövbrand, 2019, p. 529), because it calls for (intergenerational) climate justice and fundamental transformations as alternative to technological fixes. However, we also observe that the discourses overlap when NETs narratives are concerned. In the literature review and the interviews with eNGOs, we find that the argumentative structures of ecological modernization, green governmentality and civic environmentalism discourses are (in varying degree) present in the narratives and counter-narratives on NETs whenever the issue of reaching temperature targets is discussed. The strong influence of climate science is also evident: calculations of CO₂ budgets available to achieve temperature goals have become seemingly unavoidable points of reference in discourses on shaping and achieving desirable climate futures.

It remains a task for further research to map a broader range of narratives on NETs and other climate futures. Continued work on mapping visions, stories and imaginaries is needed in order to study their “respective partialities, exclusions and sociopolitical dimensions” and to “offer a more humble, reflexive, and responsible foundation for practices of future-making and sociotechnical transformations” (Longhurst and Chilvers, 2019, p. 973; see also Chilvers et al., 2021). Our study contributes to this objective by exploring narratives on NETs. Nevertheless, we recognize the limitations of our approach, which have mainly to do with the small number of interviews and the narrow focus on German eNGOs. Furthermore, the specific settings of our interviews are likely to have exerted some effects on our analysis since they come from different projects (one addressing climate engineering including CDR and the other focused on the perception of CCS).

This exploratory analysis can be a starting point for more empirical research in this direction. Further research could also strive to respond to global inequalities and take marginalized voices into account when considering narratives on NETs (e.g., Biermann and Möller, 2019). Methodologically, such endeavors can be fruitfully augmented by content analysis of policy documents and press releases as well as explicit comparisons of different socio-historical settings (such as narrative repertoires pre- and post-Paris). We also suggest that future investigations zoom in on particular NETs as our analysis indicates that there are marked differences in narratives between different kinds of technologies that could provide negative emissions.

Furthermore, power relations need to be addressed in a more encompassing fashion. The capacity and agency available to different actors for making the future an object of representation should be taken into account. This does include reflections upon the narratives that research items are transporting and this article (while aiming for a meta-perspective) is certainly no exception to this. Finally, the questions “who gets to envision the future” and who is entitled to speak on behalf of whom (Markusson et al., 2020) need to be discussed beyond the scope of this article. It will

be a task for further research to study the mobilization of multiple human and non-human actors (e.g., Latour, 2005; Whatmore, 2009) in the making and stabilization of desirable climate futures.

CONCLUSION

In this paper, we explored narratives emerging around NETs and investigated the roles that are ascribed by different actors to the IPCC as discursive source of legitimation within these stories. Theoretically, we introduced narratives from a co-productionist perspective and highlighted how they might potentially influence climate governance by defining environmental problems, elaborating consequences and outlining potential solutions. Narratives thereby strongly affect how climate policy options are perceived, communicated and legitimated. Based on a literature review of scientific articles and a complementary secondary analysis of expert interviews with German eNGOs, we find narratives that frame NETs as either a matter of necessity or a moral hazard to be most prominent in our exploratory analysis. Consequently, we focused on understanding their respective foundations, complexities, and overlaps. The IPCC is a highly important reference for these narratives, either as legitimation or as point of contention. Our results indicate that the increasingly open and explicit discussion of NETs in IPCC reports results in controversy among eNGOs that struggle to position themselves toward IPCC assessments, especially when advocating against the use of NETs. We analyzed how this spectrum of narratives links to climate policy discourses (Bäckstrand and Lövbrand, 2019). While we find that the narratives can be viewed as materializations of ecological modernization or civic environmentalism, we also see that the dividing lines between climate policy discourses blur when the role of NETs in climate change mitigation is concerned. Mapping further narratives on NETs and the visions of desirable climate futures that accompany them remains a task for future research with a broader empirical basis.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because due to privacy and ethical concerns, neither the data nor the source of the data can be made available. Requests to access the datasets should be directed to danny.otto@ufz.de.

AUTHOR CONTRIBUTIONS

DO, TT, FW, and SB contributed to conception and design of the study. DO and FW organized and conducted the expert interviews and performed the qualitative content analysis. TT did the literature review. DO wrote the first draft of the manuscript. TT and SB wrote sections of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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