How Incumbent Cultural and Cognitive Path Dependencies Constrain the 'Scenario Cone': Reliance on Carbon Dioxide Removal due to *Techno-bias*

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Executive summary

1. Motivations underlying the research

The necessity to reduce greenhouse gas (GHG) emissions to zero within the next decades to mitigate anthropogenic climate change is generally acknowledged. Yet, how to achieve this reduction remains an open debate. In this context, the use of scenarios has become common practice in order to study long-term developments necessary to reach climate targets. The scenario results enable an informed debate about climate change policy (e.g., costs, impacts, prerequisites). However, there are legitimate methodological and substantive criticisms and uncertainties with regard to scenarios.

What characteristics define a useful and scientifically well-designed scenario, as well as the choice of scenarios representing the range of plausible future developments, remain debated issues as this symposium on "Scenarios" shows. These issues are highly relevant beyond the scientific context, considering the "constitutive force" of expectations created by scenario results. These expectations condition wider social conceptions over what are realistic or unrealistic future developments, and ultimately what policies might be adopted. In order to be able to use scenarios even more profitably for climate policy decisions, it is necessary to continue a critical and reflected debate on scenarios, as it was initiated here in this symposium. To this end, we would like to provide additional impulses in this concluding article.

A look at various scenarios (and related model configurations) reveals that the range of plausible future developments is narrow. Considered developments are primarily in the technological sphere and on the energy supply side. Many scenarios assume a comprehensive implementation of Carbon Capture, Transport, and Storage (CCTS), as well as Carbon Dioxide Removal (CDR) to balance high shares of fossil fuels in the future. Contrarily, considerations of societal changes leading to energy demand reductions are rather absent. Yet, the reduction of energy demand is essential to meet GHG reduction targets without corrupting other social and environmental

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sustainability objectives. Especially CDR technologies have sparked a heated debate regarding adverse side-effects and ethical concerns.

In previous research, we could not find a satisfactory explanation for this inconsistency between the diversified problem definition and the technology-centered solution approaches. We call this imbalance *techno-bias*, which we understand as focus on technological solutions without a solid scientific basis for it. The simpler depiction in scenarios as well as path dependencies, powerful incumbent actors, and economic interests are certainly reasons why the focus is on the supply side and technological solutions. However, in our opinion, these cannot explain the strong bias alone, since it is the core task of science to study and assess the entire range of plausible options.

2. A short account of the research performed

With our analysis we want to contribute to understand the origin of the techno-bias. We therefore (1) illustrate the techno-bias based on the IPCC report and (2) assess how the techno-bias is caused by cultural and cognitive path dependencies. With this we would like to contribute to overcome this bias in scenario development and thereby broadening the scenario cone. We focus in our analysis on CDR because this large-scale technology solution plays a central role in mitigation scenarios and at the same time, the risks of a one-sided reliance on this approach are particularly drastic. However, technological solutions include not only CDR technologies but also solutions such as RES and technologically generated efficiency gains. In chapter 2, we analyze the currently available research on CDR technologies (those included in the IPCC report) to assess the potential mismatch between current knowledge, existing uncertainties and the optimistic future projections. In chapter 3, we perform based on the results of this assessment a theoretical analysis of the underlying scientific processes and transfer the resulting insights into the process of scenario development. We base our analysis on various approaches of feminist theory. These approaches allow a reflection and critique of scientific practice as well as a contextualization of underlying values and norms. Chapter 4 concludes our findings and formulates some impulses how this techno-bias can be broken up and what points need to be considered to improve future scenario building in the context of climate change mitigation.

3. Main conclusions and policy implications of the work

We argue that the selection of prominently represented scenarios (such as in the IPCC 1.5°C report) is narrowed down on technological supply side and CDR solutions because historically grown and practiced thought patterns trigger this focus. These thought patterns are characterized by dualisms, including human-nature and male-female dualism. The former makes it seem possible to control nature through technology and the latter makes the assumption plausible that control through technology is more powerful (since associated with male attributes) than behavioral change (since associated with female attributes). Our findings show that to achieve a more open and objective debate about possible climate change mitigation measures and pathways we need to reconsider underlying assumptions and biases influencing the scenario building process. Therefore we suggest inter alia to include more inter- and transdisciplinary approaches

into the scenario building process, to fully consider the complexity of ecological systems, and assess the feasibility (e.g., political, social, economic) of mitigation measures.