

BOX IV Technology and the plausibility of climate futures

Current policy debates addressing climate change and climate policy-related research emphasize the role of technology and the necessity of technological responses to reach the Paris Agreement temperature goals. This perspective is often informed by a strong belief in progress, in which technological advances are seen as a solution to limit global warming, and assuming that climate change is a technical problem, rather than a societal and structural challenge. This strong centering of technological fixes not only in imagining climate futures but also in developing emissions scenarios has been criticized by social science scholarship (e.g., Hulme, 2014; Carton, 2019; Günel, 2019; Carton et al., 2020). Nevertheless, the technological perspective has materialized in a rich literature on “socio-technical scenarios and the feasibility of transition pathways” (Aykut, Wiener et al., 2021, p.31). In transition research based on techno-economic model simulations, the question of feasibility is central and increasingly focuses on technological solutions to climate change (e.g., Jewell and Cherp, 2019; Nielsen et al., 2020). This approach comes with major shortcomings and gaps in the analysis of transition pathways, which are addressed by the CLICCS Plausibility Assessment Framework (Chapter 2). On the one hand, a decentered approach to climate research and transition (Section 2.1) has to critically reflect on the belief in technological progress (Section 6.1.10), which has a long tradition in the social fabric and imagination of Western modernity (Ezrahi, 1990). On the other hand, in socio-technical scenarios major blind spots remain. “These relate in particular to the status of history, the role of societal agency, and a bias toward enablers at the expense of obstacles to low-carbon climate futures” (Aykut, Wiener et al., 2021, p.31). Thus, a global assessment on the *plausibility* of climate futures must shift the attention to include non-economic processes as well as societal agency in order to understand how they shape transition pathways. The CLICCS Plausibility Assessment Framework neither replaces techno-economic modelling nor neglects the importance of technology. It rather complements existing approaches and addresses technology contextualized within societal dynamics and social drivers of decarbonization, instead of technological innovation as an autonomous driver of deep decarbonization.

Technology and the CLICCS Plausibility Assessment Framework

In the first Outlook, we conducted a techno-economic plausibility assessment of existing scenarios used by the IPCC and concluded that “there is substantial techno-economic evidence against the plausibility of both very low emissions scenarios compatible with 1.5°C climate futures and very

high emissions scenarios such as RCP8.5” (Held et al., 2021). Second, we reviewed the scale, depth, and speed of societal changes necessary to implement technological changes embedded in techno-economic decarbonization scenarios (Held et al., 2021). We concluded that a purely technology-driven shift to deep decarbonization does not appear plausible and that significant social transformations are necessary, in which technologies play different roles. In order to analyze required social transformations, the Outlook has developed a qualitative scenario for the social plausibility assessment, namely deep decarbonization by 2050 (Aykut, Wiener et al., 2021). The CLICCS Plausibility Assessment Framework (Chapter 2) underlines that technological responses to anthropogenic climate change shape the plausibility of climate futures, given the entanglement and mutual conditioning of social and physical dynamics. Depending on the scale and quality of technologies, they affect the physical boundary conditions of the climate system in different ways, which are however enabled and constrained by social dynamics as described by the global opportunity structure (Aykut, Wiener et al., 2021; Section 2.2). The enabling and constraining conditions of “deliberate human activities” (Canadell et al., 2021, WGI AR6 Chapter 5, p.775) in achieving net-zero carbon emissions goals and stabilizing the global surface temperature, such as carbon removal technologies, differ between individual technologies. Practicality, feasibility, and plausibility of technological responses and potential solutions are affected by questions of availability of technologies on a global and marketable scale within the foreseeable future (Held et al., 2021), of legal implementations and transitions within existing mechanism, such as the EU’s Emission Trade System (Rickels et al., 2022; Section 6.1.3), and of whether technologies, given existing social dynamics, reproduce inequalities or undermine required social transformations (Pamplany et al., 2020). Hence, the issues relating to technology and technological innovation are present in our social plausibility assessment as context conditions in individual driver assessments. For example, new communication platforms enable new forms of climate-related reporting (Section 6.1.9); enhanced Earth observation capacities facilitate improved monitoring of climatic changes (Section 6.1.10); or increasingly cost-effective renewables accelerate fossil-fuel divestment (Section 6.1.7), contribute to shifts in company strategies, and facilitate global cooperation efforts in UN climate governance (Sections 6.1.1 and 6.1.6)—and vice versa, in the case of efficiency gains in fossil-fuel generation or new technologies of extraction.

Conclusion—new technologies, new plausible climate futures?

The meaning of technology, technical responses, and potential solutions is substantially growing in various contexts of climate change. The impact of technology materializes in policy debates, imaginations of climate futures, and in various other societal processes, such as energy transition. At this point, the future of many technological developments that are currently discussed in climate debates remain highly contested. For example, renewable energy technologies such as photovoltaics, batteries, and on- and off-shore wind power, are seen as opportunities and might support decarbonization and the attainment of the Paris Agreement temperature goals. However, they still need sustained government support (or at least the removal of barriers) to be implemented at the scale and speed needed, and they are themselves in turn riddled with problematic consequences in terms of resource use and potential rebound effects. Others, such as geoengineering technologies, are highly controversial and raise concerns about further human intervention into nature, because they are seen as “artificial solution envisaging a designer climate” (Pamplany et al., 2020, p.3094, and references therein). They are meant to reduce global warming by either reducing the concentration of carbon dioxide (CO₂) in the atmosphere (carbon dioxide removal technologies such as increased CO₂ sequestration on land and in the ocean or direct CO₂ removal; Canadell et al., 2021, WGI AR6 Chapter 5) or by reducing incoming solar radiation (solar radiation management technologies; see, for example, Vaughan and Lenton, 2011, and references therein). Given continued greenhouse gas emissions, carbon dioxide removal technologies are identified as required to achieve the Paris Agreement temperature goals (IPCC SR1.5 SPM, 2018c). Yet they cannot replace emissions reductions and come with substantial social and political challenges. Though researchers spend a lot of effort in analyzing the effectiveness of these technologies, potential side effects, reversibility, and risks of failure (Vaughan and Lenton, 2011), such technologies remain uncertain in terms of feasibility and plausibility on a meaningful scale. Large-scale CO₂ removal needed to compensate today's emissions is currently not plausible, since the technologies are either still unable to remove enough CO₂ or are not yet available (Canadell et al., 2021, WGI AR6 Chapter 5). At the same time, remaining blind spots concern the understanding and analysis of social and environmental implications of technological responses to climate change (e.g., Stenzel et al., 2021). In summary, not only the feasibility of technologies identified as central in current policy debates, but also their plausibility in light of climate futures remain highly uncertain.

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