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HAMBURG CLIMATE FUTURES OUTLOOK



Assessing the plausibility of
deep decarbonization by 2050



Universität Hamburg

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CLUSTER OF EXCELLENCE
CLIMATE, CLIMATIC CHANGE,
AND SOCIETY (CLICCS)

About CLICCS

Researchers from a wide range of disciplines have joined forces at the Cluster of Excellence CLICCS (Climate, Climatic Change, and Society) to investigate how climate and society will co-evolve. The CLICCS program is coordinated through Universität Hamburg's Center for Earth System Research and Sustainability (CEN) in close collaboration with multiple partner institutions and is funded by the Deutsche Forschungsgemeinschaft (DFG).

About the Outlook

In the annual *Hamburg Climate Futures Outlook*, CLICCS researchers make the first systematic attempt to assess which climate futures are plausible, by combining multidisciplinary assessments of plausibility.

The inaugural 2021 *Hamburg Climate Futures Outlook* addresses the question: Is it plausible that the world will reach deep decarbonization by 2050?

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Epistemological challenges for assessing plausibility

- 2.1** Identifying physical plausibility
- 2.2** Identifying social plausibility
- 2.3** Combining physical and social plausibility assessments
- BOX I** *The Hamburg Climate Futures Outlook* and other assessments of climate futures

2

Epistemological challenges for assessing plausibility

In order to separate plausible climate futures from those that are merely possible, we must grapple with two radically contrasting disciplinary approaches to probability. In the physical climate sciences, there is a well-established practice of estimating the probability of future states of the climate, given assumptions about greenhouse gas emissions and other external influences. However, most social sciences have good reasons to avoid any probabilistic description of future states of society. Our starting point for working on future societal developments (including the economy, politics, and culture) is to assume that the future is pre-conditioned

but undetermined. Future social developments are pre-conditioned in that they are partly influenced by the past or by past decisions, which can favor particular pathways (*path dependency*) and lend the social system a certain inertia, inhibiting rapid change. However, in the social system, departures from the expected path (*path departure*) and disruptions are quite common too, causing even very basic constituents of the social system to change in unexpected ways. Here we discuss how the physical and social science approaches to future changes can be brought together for the purpose of assessing plausibility.

2.1

Identifying physical plausibility

In the physical climate sciences, estimates of possibility and plausibility derive from knowledge of the deterministic and stochastic behavior of the climate system. Deterministic behavior refers to mechanisms that determine the impact of changing external influences in ways that are known in principle, even if they cannot be quantified with certainty. For example, there are well-established mechanisms that link increasing atmospheric CO₂ concentrations to future long-term global surface warming, and the quantification of that future warming can be expressed as a probability range (e.g., Collins et al., 2013).

In addition, climate can vary without any external influence. Local manifestations of seasons are examples of such variation: no two summers are exactly alike. Global surface temperature can also naturally fluctuate about an average state, even on decadal timescales. This type of internal variation can be considered a stochastic and largely unpredictable process. However, scientific investigation of the stochastic processes indicates that not all variations are equally likely to occur on particular timescales, so that internal variability, too, can be expressed as a probability range (e.g., Maher et al., 2019).

The full range of physically possible climate futures is derived from a combination of the deterministic behavior, internal variability, and their uncertainty distributions (e.g., Marotzke and Forster, 2015). The associated probabilities make futures either merely possible—if they can conceivably occur but have low probability—or plausible, if they can occur with appreciable probability.

2.2

Identifying social plausibility

The social dynamics of climate futures are too complex to be described probabilistically. And yet, not all possible scenarios of a societal future seem equally plausible, since there are certain qualities of the present that can be interpreted as pointing toward or away from a particular future (Pulver and Vandevier, 2009; Staman et al., 2017; Bas, 2021). For some dynamics in the social system, trend extrapolations are possible and have predictive power. But in the past, unforeseen events and disruptions have also ended existing trends and led to new pathways. The fall of the Berlin Wall is an example of such an unforeseen and disruptive event. Other observed deep transformations of the past have taken place not as the outcome of planned action, but rather as accumulated side effects (Sinha, 2018) or as slow cultural change that evolves over decades or even centuries, such as the gradual global diffusion of carbon-intensive lifestyles before they entered an exponential-growth phase in the second half of the twentieth century.

Some existing methods attempt to improve prediction capacities in the social sciences (e.g., Armstrong, 2001; Taleb, 2007; Ungar et al., 2012; Mellers et al., 2015; Tetlock and Gardner, 2016), and some attempts at prediction have even been successful (Silver, 2012). However, these forecasts are usually targeted only at partial components or one-off events in the social system, such as elections, or trends in the financial market. Yet, the challenge for understanding the social plausibility of climate futures is that society, with all of its internal driving forces, cannot be reduced to partial components such as elections. Society is highly complex and does not have a center from which it can be organized hierarchically and controlled effectively in the name of a global “we”, although this misconception still implicitly informs much thinking about transformations in the Anthropocene (Grundmann and Rödder, 2019; Neckel, 2021). Attempts to control some part of society always produce unintended consequences and spillover effects in other parts. Examples include implementing strict anti-pollution controls, when the pollution is simply shifted to other locations, or the closure of a heavily frequented road for through-traffic, when traffic finds its way around the closed road.

To deepen our understanding of social change, we examine the interplay between societal actors and structures. Societal actors can bring about change when powerful individuals or groups, such as governments or large multinational corporations, make decisions that influence social behavior. Change can also be brought about by individuals with less power when they gather in large numbers under a common purpose, such as in social movements, or when the aggregated behavior of many individuals shifts, such as when consumption patterns and investment patterns change over time. Societal structures describe the social context within which the actors operate; this context can precondition plausible actions and thus create path dependencies. However, structures can also be modified by societal actors—sometimes drastically—leading to new conditions and new opportunities for future social behavior, or to departures from the expected path. One example of such structural change would be a switch of the global political system from one type of multilateral world order to another (Viola, 2020), modifying the preconditions for achieving global agreements. A further example is the industrial revolution and the profound transformations it brought to capital owners and workers.

Identifying social plausibility therefore requires a methodology that recognizes the future as simultaneously undetermined and pre-conditioned. Social transformation, when it occurs, can be sudden, but it can also be slow and evolutionary. To assess the plausibility of climate futures, the methodology must also acknowledge the potential for social change, and that even the fundamental constituting elements of the observed system can change and create entirely new conditions for future emissions pathways (see Chapter 4). We assess social plausibility by developing a theoretical model of transformation, and by using this model to interpret existing empirical evidence.

2.3

Combining physical and social plausibility assessments

Narrative scenarios of future climate offer a common ground on which to combine social and physical plausibility of climate futures. The newest IPCC Assessment Reports, for example, assess plausible physical dynamics conditioned on a set of scenarios called the Shared Socioeconomic Pathways (SSPs). These scenarios describe potential future social and techno-economic dynamics that might lead to particular emissions pathways. Any stated plausible range of surface warming is only valid assuming a particular emissions pathway, which in turn assumes that the underlying social and techno-economic dynamics indeed unfold.

The SSPs are designed to describe a wide range of social futures (Riahi et al., 2017); they include futures with international conflict, futures with international cooperation, and futures with either high or low challenges to mitigation and adaptation. The range of possible social dynamics are thus left relatively unconstrained across the SSPs. By contrast, the SSPs comprise substantial techno-economic constraints, in that they are usually the result of an economic optimization that considers the cost of various technological options, especially in the energy sector. Based on the existing literature, Chapter 3 assesses the techno-economic assumptions behind the existing SSPs, providing a reduced range for techno-economic plausibility of emissions scenarios.

Since the techno-economic assessment omits essential aspects of social dynamics for climate futures, we add a critical extension. We propose a scenario suitable for a social plausibility assessment—*deep decarbonization by 2050* (Chapter 3). We assess this scenario using the Social Plausibility Assessment Framework, which we develop and present here for the first time (Chapters 4 and 5). In a further step, we ask what the relatively specific techno-economic assessment and the wider social plausibility assessment imply for the physical plausibility of global surface warming scenarios. This allows us to present the first combined social and physical plausibility assessment of global surface warming (Chapter 6), which represents a key advancement in the science of climate futures.

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