On the Exploration of German Mitigation Scenarios

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Summary

The decisive mitigation of greenhouse gas emissions in order to avoid dangerous anthropogenic interference with the global climate system constitutes one of the greatest challenges of the 21st century. Germany is being observed by the global community on its unprecedented quest for decoupling a highly industrialized country's economy from CO_2 emissions and has ambitious long-term mitigation targets. Due to the complex challenge of transforming Germany's energy system, political actors frequently demand scientific expertise in the form of long-term, model-based mitigation scenarios. However, existing mitigation scenarios for Germany suffer from severe methodological shortcomings and are highly intransparent on their implicit normative assumptions. This is not reconcilable with the good principles for the science-policy interface. Thus, the guiding theme of this thesis is to explore how implicit normative considerations in model-based mitigation scenarios can be made explicit.

The first part of this thesis conducts an exploratory research that intends to overcome the current limitations in model-based mitigation scenario development by applying a collaborative scenario definition and evaluation process engaging civil society stakeholders. Taking an analytical-deliberative approach to participation, civil society stakeholders from the transport and electricity sector frame the definition of boundary conditions for the hybrid energy-economy model REMIND-D and evaluated the resulting scenarios with regard to plausibility and socio-political implications. The developed mitigation scenarios for Germany achieve 85% CO_2 emission reduction in 2050 relative to 1990. However, the scenario evaluation unravels that the technological solutions to the mitigation problem proposed by the model give rise to significant societal and political implications that deem at least as challenging as the mere engineering aspects of low-carbon technologies. These insights underline the importance of comprehending mitigation of energy-related CO_2 emissions as a socio-technical transition embedded in a political context. The second part of this thesis explores alternative German mitigation scenarios for identifying what kinds of energy strategies for transforming the German electricity sector towards high shares of renewable electricity generation (RES-E) they embody and under which premises they are viable. It performs a comparative meta-analysis of ten model-based mitigation scenarios from six recent publications, including those developed in the first part of the thesis. The scenarios group into three different energy strategies that exploit the basic options of increasing RES-E shares (domestic RES-E production, energy efficiency improvements and RES-E imports) to a different extent. Substantial behavioral, institutional and engineering barriers to implementation that apply to all suggested energy strategies are identified. Upon investigating the reasons why the different scenario projections diverge, it turns out that they are in many cases based on expert judgments rather than resulting from numerical modeling. These involve normative judgments and need to be made more explicit in future research.

In sum, this thesis reveals in exploratory research that the realization of a collaborative mitigation scenario definition and evaluation process, as a means to address normative considerations in model-based mitigation scenarios explicitly, is possible in small scale and scope. Hence, the primary message for future research is that such a participatory process should be repeated in the form of a more comprehensive assessment of German mitigation scenarios, which requires refined participatory methods so as to keep transaction costs within boundaries. It is commendable to adapt the elaborated methods developed in the literature on inclusive risk governance, which extensively deals with the questions of whom to include in a discourse, for what reasons and by means of which methods.