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Locked into Copenhagen pledges — Implications of short-term emission targets for the cost and feasibility of long-term climate goals

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ABSTRACT

This paper provides an overview of the AMPERE modeling comparison project with focus on the implications of near-term policies for the costs and attainability of long-term climate objectives. Nine modeling teams participated in the project to explore the consequences of global emissions following the proposed policy stringency of the national pledges from the Copenhagen Accord and Cancún Agreements to 2030. Specific features compared to earlier assessments are the explicit consideration of near-term 2030 emission targets as well as the systematic sensitivity analysis for the availability and potential of mitigation technologies. Our estimates show that a 2030 mitigation effort comparable to the pledges would result in a further "lock-in" of the energy system into fossil fuels and thus impede the required energy transformation to reach low greenhouse-gas stabilization levels (450 ppm CO_2e). Major implications include significant increases in mitigation costs, increased risk that low stabilization targets become unattainable, and reduced chances of staying below the proposed temperature change target of 2 °C in case of overshoot. With respect to technologies, we find that following the pledge pathways to 2030 would narrow policy choices, and increases the risks that some currently optional technologies, such as carbon capture and storage (CCS) or the large-scale deployment of bioenergy, will become "a must" by 2030.

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1. Introduction

Limiting climate change has been the subject of international negotiations for more than 20 years. In this process, long-term aspirational goals have been identified by the Parties to the UNFCCC with more than 190 countries supporting goals to keep global temperature rise to below 2 °C compared to pre-industrial times [1]. Achieving this objective requires a fundamental transformation of the energy and other greenhouse gas emitting sectors in order to reduce emissions and to stabilize their concentrations in the atmosphere [2–6]. A globally comprehensive agreement with binding emission limits to achieve this goal is currently lacking. Instead, the Kyoto Protocol has been extended and countries have made pledges to reduce their emissions in the near term, i.e. by 2020, first as part of the Copenhagen Accord, later anchored in the 2010 Cancún Agreements [7].[1] The countries with pledges represent about 80% of current global emissions [8].

The implications of the near-term pledges for the feasibility and costs of long-term targets are poorly understood. Previous studies indicate that the emissions resulting from the pledges would be higher than the least-cost emission pathways of most scenarios reaching 2 °C (e.g. [9,10]). This is, for instance, assessed in the UNEP Emissions Gap Reports [8,11] and in Höhne et al. [12]. The pledges correspond thus to a relatively modest climate policy signal, leading in the near-term to an "emission gap" compared to optimal pathways toward 2 °C [13]. The explicit analysis of the long-term consequences of this emission gap has, with a few notable exceptions [14–16], not been conducted at this time.

In this paper we present an overview of the AMPERE model comparison with focus on the implications of modest short-term policies to 2030. In this context, we assess the emission consequences of the pledges for the year 2020, and specifically explore the implications if the policy stringency of the pledges would continue to the year 2030. In total nine international integrated assessment modeling teams have participated in the model comparison and developed a set of more than 300 scenarios based on harmonized assumptions about the pledges and other factors (see Section 2 on methods). The diversity of modeling approaches permits us to cover a wide range of dynamics and to explicitly explore uncertainty owing to structural as well as parametric differences between the models. Our paper is complemented by a second AMPERE modeling comparison exploring the implications of different regional accession rules for long-term climate policy objectives [17] (in this issue). In addition, a series of papers in this issue present insights of individual modeling teams in greater detail [18–22].

Stabilizing global temperatures requires a limit on the cumulative amount of long-lived greenhouse gases emitted to the atmosphere [23–26]. Any lack of emission mitigation over the near term will need to be compensated thus by more stringent and more rapid emission reductions later in the century. Key questions addressed in the paper are, therefore, whether the "gap" can still be closed and long-term targets be attained if the world delayed stringent policies up to 2030? What are the implications for the pace of the future energy transformation, considering particularly the inertia of the system against rapid changes? How would the overall costs of mitigation be affected, and which technologies might be critical for bridging the near-term emission gap?

A distinguishing feature of our modeling comparison is the explicit consideration of short-term targets in order to explore trade-offs between the required near-term emission mitigation, and their consequences for the attainability of alternative climate targets in the long term. We specifically focus on the 2030 time-frame for the short-term targets. This time-frame is of high policy relevance as our analysis could provide important guidance for the required stringency of post-2020 targets on which the negotiations will need to increasingly focus during the coming years. For an assessment with focus on the 2020 time-frame see [27–30].

Choices about mitigation technologies as well as society's ability to limit energy demand play a critical role for the nature, direction, and attainable pace of the energy transformation and associated greenhouse gas emission reductions [2,15,31–35]. We thus conduct also a systematic technology sensitivity analysis and explore the implications if the deployment of certain mitigation technologies would become more restricted compared to their full potential. These restrictions reflect possible political choices with respect to more controversial options, such as nuclear or carbon capture and storage (CCS) (see, e.g., [36,37]), but can also be the result of technical or other implementation barriers (e.g., variable renewable energy that may face challenges with respect to systems integration [38,39], or biomass that may face restrictions due to competition over land [40]). The analysis of supply-side technologies is complemented by a sensitivity analysis on the demand-side to better understand the potential contribution of efficiency and energy intensity improvements. The technology sensitivity cases were closely coordinated with the parallel ongoing modeling comparison of the Energy Modeling Forum (EMF27) [41].

In this paper, we first describe methods and scenario design (Section 2), and then turn to the critical question of the implications of alternative near-term policies for the timing of mitigation and greenhouse gas emission pathways. Section 3 explores consequences for the required pace of the energy transformation, and Section 4 examines costs and feasibility issues. Section 5 concludes.

2. Methodology and scenario design

Our study employs nine different global integrated assessment models of the economy with alternative representations of the main greenhouse gas emitting sectors. We use the models for the development of a set of long-term climate stabilization scenarios for the 21st century.

In order to explore the consequences of near-term pledges, our scenarios consider a combination of different short-term and long-term targets, which divide the century-scale time horizon of the scenarios into two stages. During the first stage up to the year 2030, global emissions are required to follow a trajectory toward a 2030 emission target. After 2030, emissions are constrained further to stay within a cumulative emission budget for the full century (2000–2100) in order to achieve stabilization of greenhouse gas concentrations in the

[1] The extension of the Kyoto Protocol implied that only some Annex-I Parties joined the Protocol and that their targets correspond to the low-ambition pledges that were made in Cancún.

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