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The implications of initiating immediate climate change mitigation — A potential for co-benefits?

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ABSTRACT

Fragmented climate policies across parties of the United Nations Framework on Climate Change have led to the question of whether initiating significant and immediate climate change mitigation can support the achievement of other non-climate objectives. We analyze such potential co-benefits in connection with a range of mitigation efforts using results from eleven integrated assessment models. These model results suggest that an immediate mitigation of climate change coincide for Europe with an increase in energy security and a higher utilization of non-biomass renewable energy technologies. In addition, the importance of phasing out coal is highlighted with external cost estimates showing substantial health benefits consistent with the range of mitigation efforts.

1. Introduction

Within documents related to the Doha Climate Change Conference in November 2012, "grave concern" was noted as there is still a "significant gap between the aggregate effect of Parties' mitigation pledges … and aggregate emission pathways consistent with having a likely chance of holding the increase in global average temperature below 2 °C" (UNFCCC, 2012a [27,13]). Fragmentation is a suitable description of global climate policy action as countries follow their own policy agendas. On the other hand, a topical case of a region leading the way by initiating more stringent climate action is the European Union and the implementation of the "Roadmap for moving to a competitive low-carbon economy in 2050" (short: EU Roadmap). Within this Roadmap both immediate mitigation efforts and large-scale reductions of emissions by 80–95% below emissions in 1990 have been proposed, refer to [9]. Alas, pioneering with mitigation efforts in a world of fragmented climate policies leads to a question of whether initiating significant and immediate climate change mitigation can support the achievement of other non-climate objectives. More specifically, we ask whether such co-benefits exist regardless of how the rest of the world responds to Europe's pioneering action.

Using the results from eleven global integrated assessment models (IAMs), we focus our analysis on potential co-benefits connected with energy security and air pollution. With respect to energy security, we study the development of import dependence on fossil fuels as well as the impact on Europe's bill for oil and gas. We also review energy diversity indicators (Section 3.1). Regarding, the side-effects of climate change mitigation efforts on air pollution (Section 3.2), we review whether external costs avoided in the electricity sector are sizable in comparison to the overall policy cost. In addition, we highlight the sources of the greatest potential co-benefits which underlie the sectoral estimates with a focus on eight different energy sources (including nuclear, a range of renewable energies (RE), coal, oil, and gas).

To test the robustness of co-benefits across varying mitigation efforts in a fragmented world, we analyze different climate

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policies which have been implemented by eleven IAMs, refer to Kriegler et al. of this issue [20]. In particular, we look at the following subset of scenarios with a focus on the European Union:

- *Fragmentation — RefPol*: Countries have their own agenda and follow more or less stringent climate policies. This scenario is an extrapolation of unconditional climate policies that are currently in place based on the Copenhagen Pledges.
- *Concerted action — CF450*: The world jointly commits to a 450 ppm target with flexibility allowed in the models' response to the target in terms of the timing of emission reductions.
- *Inspiration — 450P-EU*: The European Union pioneers with more stringent climate policies as foreseen in the EU Roadmap 2050. Inspired by this early action, the world makes a transition to a global emission reduction path consistent with a 450 ppm target.
- *Disillusion — RefP-EUback*: The European Union pioneers with its Roadmap 2050 but does not succeed in inspiring the world to follow, the EU then returns to the less stringent climate policies of the fragmented world from 2030.
- *No policy case — Base*: Countries do not follow any climate policies, and hence, the shadow price of greenhouse gas (GHG) emissions is zero.

Studies related to ours are [4,11,12,18]. Knopf et al. [18] is a model inter-comparison exercise of the energy modeling forum, EMF 28, focused on EU 2020 and 2050 climate targets with a review of different technological futures. Their analysis of the EU Roadmap strategy suggests that a reduction of GHGs by 80% in 2050 is possible but challenging as strong cost increases take place from 2040. The authors also conclude that it is necessary to start the transformation of the energy system before 2030. References [11,12] are the official assessments carried out for the development of the EU Roadmap 2050. Capros et al. [4] discusses related energy projections of the scenarios used for the EU Roadmap 2050. Both studies are based on the model PRIMES.

In this paper we define co-benefits as a positive physical side effect of one policy (here climate policy) for another public policy objective (see also [8]). The following papers take up a similar discussion of climatic co-benefits as we do: in a single-model study McCollum et al. [23] find co-benefits in an increasing renewable energy (RE) deployment in terms of energy security and air pollution. Borenstein [2] discusses potential co-benefits of RE such as their contributions to alleviating externalities from fossil fuel burning, energy security improvements, reducing the vulnerability of energy market prices, and the creation of jobs. Due to various methodological shortcomings (e.g. the market value of electricity depends on time and location, the problem of how to account for variability) the author concludes that environmental co-benefits may be more important. Similarly, Edenhofer et al. [7] argue that a possible benefit of RE (as a decentralized energy option) is that they can play an important role in improving access to energy in rural areas. A note of caution should be raised as co-benefits should also be assessed in a more complex framework, i.e. taking account of competing public policy objectives, which to the authors' knowledge have not been completed to this date.

The paper is structured the following way. In Section 2, we introduce details of the scenario design and briefly review participating models. We also compare GHG emission reductions in these scenarios with those defined in the EU Roadmap 2050. In Section 3, we analyze co-benefit candidates as they were described above. The concluding section summarizes our findings on possible sources of co-benefits.

2. Europe's early action in a world of fragmented climate policies

In this section we provide details on the scenario framework and on participating models. We then study the consequences for the development of GHG emissions across the different scenarios. As expected the EU Roadmap 2050 implies more stringent climate policies in comparison to the unconditional Copenhagen Pledges which are the basis of the fragmented regional action scenario.

2.1. Scenario design

The current world with fragmented climate policies is characterized by diverse levels of ambition with respect to mitigating climate change. These are expressed in our scenarios with different targets across the globe for GHG emission caps and intensities, shares of RE in electricity production or final energy, and capacity targets for low carbon technologies (wind, solar, geothermal, and nuclear energy). Apart from these targets, which are based on a review of current climate policies, the development of GHG intensity rates from 2020 was projected reflecting current trends and planned policies.[1]

More specifically, the scenario 'Fragmentation' (short: RefPol) is an extrapolation of climate policies that are currently in place based on the unconditional Copenhagen Commitments and national/regional low carbon technology targets (if these exist). The European Union has a moderate GHG reduction target of 15% in 2020 with the aim of achieving a 20% share of RE in final energy by 2020. After 2020, we assume that the GHG intensity falls at least at 3% p.a. in the European Union. Fig. 1 also provides an overview of emission caps and constraints on the development of GHG intensities as imposed in other world regions. Assumptions in these regions concerning technology targets for RE shares and/or capacities for low carbon technologies are provided in [20]. Note, that neither emission trading between regions nor banking and borrowing are allowed.

As opposed to the fragmented climate policy action in different world regions, we also study scenarios of immediate 'Concerted action' where the world aims to stabilize atmospheric GHG concentrations at 450 ppm CO_2se. These constraints on GHG emissions are imposed for all sectors, incl. land-use change (short scenario name: CF450). The full basket of GHGs includes CO_2, CH_4 (GWP 25), N_2O (GWP 298), and F-gasses. Note however, that the model IMACLIM reports only CO_2 and the model POLES does not report N_2O and CH_4. To harmonize targets between models capturing different baskets of GHGs, models were provided with a cumulative carbon dioxide budget for the period 2000–2100 (1500 $GtCO_2$ and 2400 $GtCO_2$ for 450 and 550 ppm CO2e targets, respectively).

In scenarios 'Inspiration' (short: 450P-EU) and 'Disillusion' (short: RefP-EUback) the EU pioneers with more stringent

[1] Note that all climate policies have been implemented by means of equivalent regional taxes on GHG emissions' running auxiliary scenarios. These taxes represent the shadow price of the quantity instruments.

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