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Costs of Emission Metrics in the Context of Climate Stabilizations

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The United Nations Framework Convention on Climate Change (UNFCCC) calls for stabilization of greenhouse gas (GHG) concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system (Article 2) and stipulates that policies and measures should cover all relevant sources, sinks and reservoirs of greenhouse gases (Article 3.3). An emission metric to evaluate emissions of non-CO_2 gases on a common scale of CO_2 is critical for climate policymaking and also essential in a single basket approach to GHG emission abatement to achieve climate stabilization (for example, at 2°C warming target as recognized in the Cancún Agreements). While the Global Warming Potential (GWP) is by far the most common metric used in climate policies (e.g. Kyoto Protocol), alternative metrics are proposed to overcome deficiencies in the GWP. Those include the Cost-Effective Temperature Potential (CETP), Forcing Equivalent Index (FEI), Global Cost Potential (GCP), Global Damage Potential (GDP), Global Temperature change Potential (GTP), Mean Global Temperature change Potential (MGTP), Peak Commitment Temperature (PCT), Regional Temperature change Potential (RTP), Sustained Emission Temperature (SET), and TEMperature Proxy index (TEMP).

A number of studies provide estimates of such metrics for different gases under a variety of assumptions and approaches. It has been demonstrated that emission metrics take a large range of values when compared in the context of climate stabilization, depending largely on the metric structure and the treatment of the time dimension. On the contrary, the differences in stabilization costs arising from the choice of metrics are shown to be disproportionally small in both cost-effectiveness and cost-benefit frameworks (i.e. a few to several percent higher costs relative to those based on optimal price ratios). However, only a limited set of metrics has been a subject of cost estimation and such calculations have been performed under restrictive non-overshoot emissions scenarios. In view of the current literature on emission metrics that has burgeoned in recent years, there is a need for studies addressing a comprehensive set of metrics to investigate their impacts under a variety of emissions scenarios.

Our study shows how the choice of metrics influences stabilization pathways and resulting abatement costs over the long term including post-stabilization periods. In selected cases we allow for a temporary overshoot above the long-term stabilization level, in which biomass with CO_2 capture and storage (bioCCS) is assumed feasible in the latter half of this century, leading to negative CO_2 emissions. Furthermore, our study investigates the climate commitment at the time of stabilization to illuminate how the choice of metrics influences the mix of greenhouse gas emissions along the stabilization pathway, thereby affecting long-term climatic implications beyond stabilization.