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ADVANCE

**Advanced Model Development and Validation for Improved Analysis of
Costs and Impacts of Mitigation Policies**

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Policy Brief

Structured sensitivity analysis helps understand key uncertainty dimensions

IAMs help to elucidate the dependency of mitigation strategies on a host of assumptions, for instance future socio-economic developments. The uncertainty in these assumptions results in a high degree of uncertainty in model results. To better quantify the sensitivity of results to specific assumptions, ADVANCE engaged in a structured uncertainty analysis drawing on the framework of the Shared Socio-economic Pathways (SSPs).

These SSPs have been developed to describe alternative narratives regarding socio-economic developments, spanning a wide range of plausible futures. So, for instance, while SSP1 assumes a future that is moving towards a more sustainable path, SSP2 describes a future in which development trends are not extreme, but rather follow middle-of-the-road pathways. In ADVANCE we have used this new scenario platform to improve the understanding of how future CO₂ emissions from fossil fuels are influenced by the key drivers characterising the SSPs. We used six state of the art climate-economy-energy integrated models to explore the impact of five key factors: population, income, energy efficiency, fossil fuel availability, and low-carbon energy technology development.

Uncertainty analysis of this kind has rarely been done in the past due to the computational complexities of assessing all the interdependencies. To overcome this problem, we used a newly developed decomposition algorithm which has allowed us to compute both the direct effect of each of the underlying drivers of emissions, as well as the interaction between the different drivers.

The results of this multi model, global sensitivity analysis has revealed that the assumptions about energy intensity and economic growth are the most important determinants of future emissions. This is depicted in Figure 1. Interaction terms between parameters have been shown to be important determinants of the total sensitivities. The results suggest that improving the understanding of energy efficiency should be a crucial priority for future research, as it has substantial potential for reducing uncertainty in IAM projections.



Fig. 1: Projected change in cumulative CO₂ emissions from fossil fuels up to mid-century when passing from the SSP2 “Middle of the road” to the SSP1 “Sustainability” narrative. The biggest emission changes are attributed to income (GDPPC) and energy efficiency (END), while population (POP), fossil fuel availability (FF) and low-carbon energy technology development (LC) are less influential.

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