WHY DO MITIGATION PATHWAYS DIFFER? THE ROLE OF SCENARIO ASSUMPTIONS AND MODEL FEATURES

Jim Skea, Imperial College London, j.skea@imperial.ac.uk
Richard Green, Imperial College London, r.green@imperial.ac.uk
Alaa Al Khourajie, Imperial College London, a.alkhourajie@imperial.ac.uk
Raphael Slade, Imperial College London, r.slade@imperial.ac.uk
Iain Staffell, Imperial College London, i.staffell@imperial.ac.uk

Overview

The process of developing long-term emission pathways involves constructing simplified representations of a complex system which capture societal socioeconomic features, the level of energy and land use, and changing climate indicators and their impacts. Two tools developed by the scientific community constitute key inputs for this process: scenarios that represent alternative societal futures (e.g. urbanisation, economic growth) and integrated assessment models that explore, in a formal and consistent framework, the response of these complex systems to changes in policy, mitigation strategies and various key assumptions and constraints (e.g. technology, capital accumulation).

For the IPCC's Sixth Assessment Report (AR6), Working Group III has developed a database with over 1,000 sets of input assumptions and model results, built from several model comparison projects and individual datasets submitted to the IPCC, all based on published work. The input assumptions are based on the Shared Socioeconomic Pathways (SSPs) database. This paper will use econometric techniques to assess the degree to which mitigation indicators such as the deployment of specific technologies or the level of final energy demand are influenced by background socioeconomic scenarios (e.g. SSPs), the level of climate ambition, and the choice of models.

Which inputs have a large impact on the resulting pathways, and how robust are these impacts to the model used? Which features of the pathways in the database are common across many SSPs and many models? How should we communicate with policymakers about the degree to which these future mitigation indicators rely on the tools deployed for assessing them?

Methods

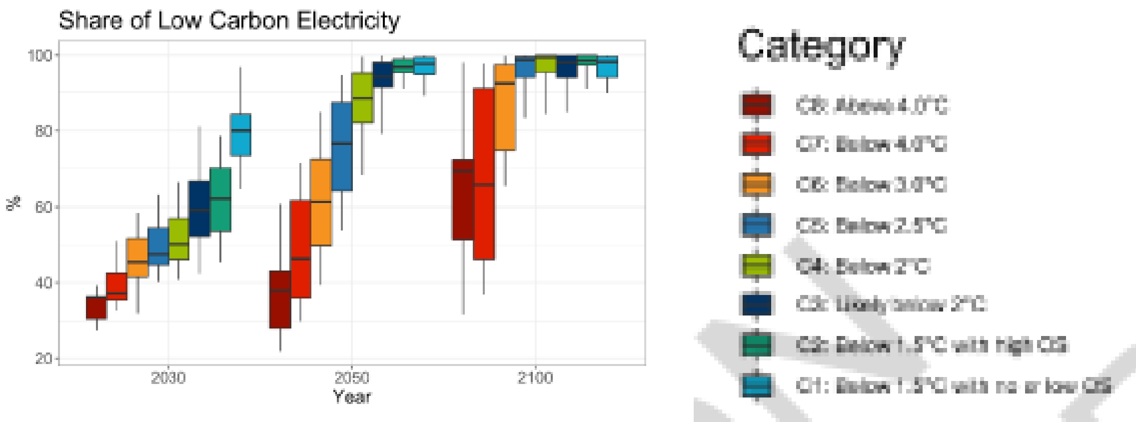
The IPCC Scenarios database forms a multi-dimensional panel, with results at 10-year intervals from many different models across a range of scenarios, mostly defined in terms of their climate ambition (including current policies only; policies that meet Nationally Determined Contributions (NDCs) under the Paris Agreement; restricting the temperature rise by 2100 to 2 degrees C with a 50% probability; restricting the temperature rise by 2100 to 1.5 degrees with minimal overshoot).

We will use panel data econometrics to untangle the factors influencing predictions such as the carbon price, the level of energy demand, the share of different kinds of renewable energy and the cost of mitigation. How far do these depend on the level of climate ambition and how much are they affected by the choice of model? We will compare fixed and random effects models, concentrating on predictions for the middle of the century as this is likely to show the greatest diversity between ambition levels, and perhaps between models.

Results

We do not yet have results to report, as the relevant IPCC report was only released a few days ago, and only some of the authors of this study had access to the database before that release. Now that the data are available, we hope to make rapid progress and have already selected and cross-plotted the data of greatest interest from it.

Chapter 3 of the WGIII Contribution to AR6 describes and graphs the models in the database; the figures below are examples from the chapter showing how the share of low-carbon electricity rises over time and with the level of climate ambition. We expect to go beyond this analysis to investigate how far models systematically differ in their predictions, and how far this depends on the scenario. For example, in the diagram below, drawn directly from the IPCC report, the share of low-carbon electricity in 2100 varies widely in the results (in red) representing "business as usual" whereas it is close to 100% for all of the results (in blue and green) with (successful) strong climate action; there is more diversity in those pathways earlier in the century. We will formalise and quantify these statements, and hope to draw out relationships between (e.g.) carbon prices and the use of a range of technologies.



Source: Riahi, Schaeffer *et* al. (2022) Figure 3.23. Low-carbon includes non-biomass renewables, biomass, nuclear and CCS. Models were categorised according to the temperature change predicted when their emissions results were analysed by the IPCC team using a climate emulator.

Conclusions

It is too early to draw conclusions; we hope to be able to answer the question of "how much do models matter?", showing whether there are systematic differences between models when analysing a similar scenario. We also hope to show where models are largely in agreement; technologies with uniformly large future market shares deserve priority for research and development; those which never rise above negligible levels do not.

References

Riahi, K., R. Schaeffer *et al.* (2022) "Mitigation Pathways Compatible with Long-Term 2 Goals", Chapter 3 of Working Group III Contribution to the IPCC Sixth Assessment Report (AR6).