Tracing the transformation through a decade of mitigation scenarios

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NDC ASPECTS IAM COMPACT

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1 Introduction

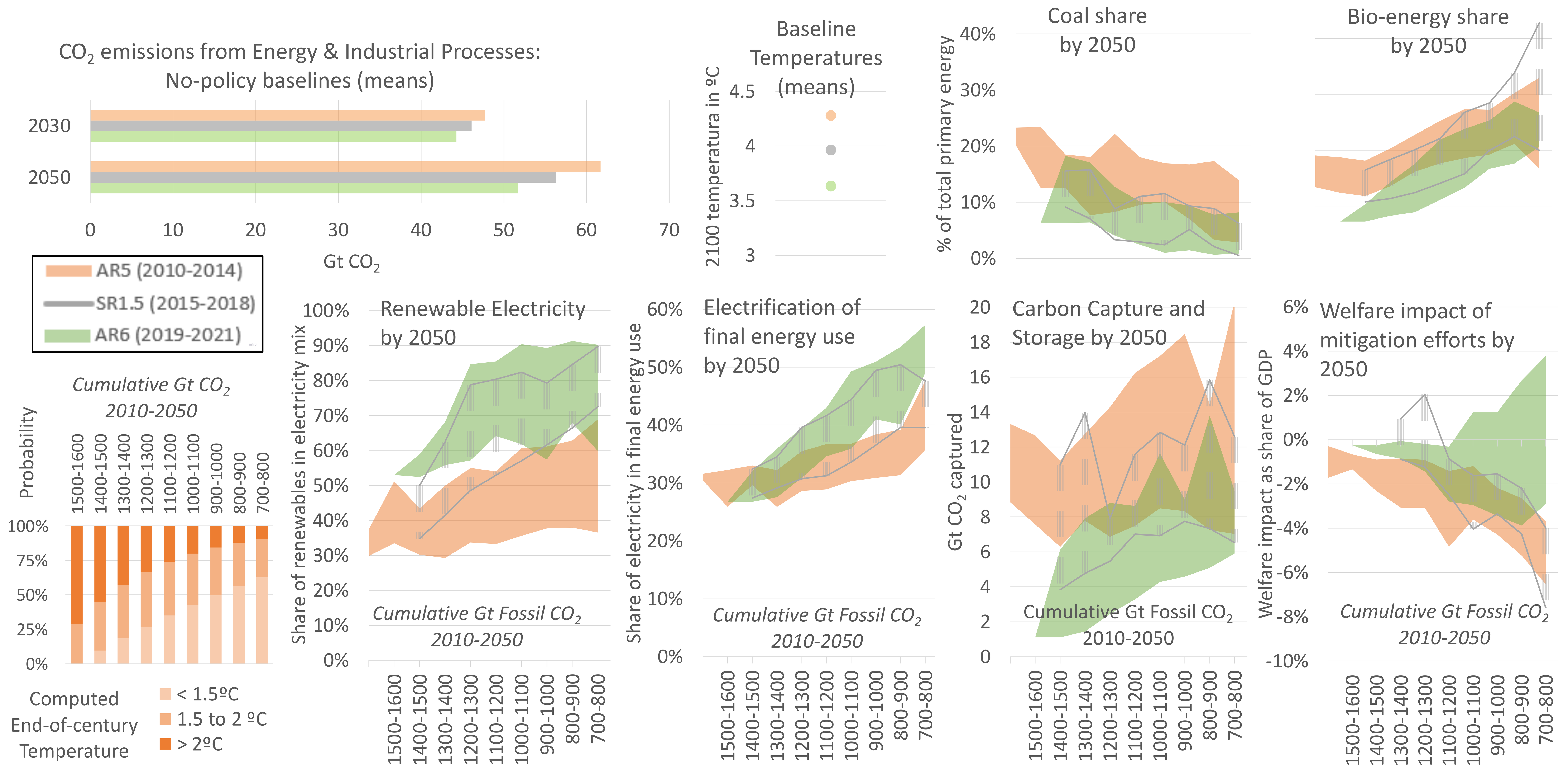
Since the early 2010s, the scientific field of integrated assessment modelling grew significantly in terms of research output and user interest, driven by the widespread acknowledgement of climate change and of the need to mitigate it, as well as by the emergence of emission reduction strategies and the policy community's interest in technical capacity to support these strategies. Thousands of scenarios projecting mitigation pathways with pre-defined emissions or climate targets have been published in the academic and grey literature with a set of variables revealing how the emissions reductions can be realized across countries and sectors.

We evaluate how mitigation strategies have evolved over the last decade in these scenarios. We analyse the role of energy carriers, technologies, sectors, and options in global mitigation scenarios developed by Integrated Assessment Models (or Energy System Models). Data from mitigation scenarios included in the IPCC AR5, SR1.5, and AR6 databases are gathered, compiled, and compared ([1-4]). The purpose of this exercise is to understand the direction, in which climate change mitigation portfolios have evolved from a modelling perspective, and the driving factors behind this evolution over time.

2 IPCC Data Analysis Techniques

First, we look at how no-policy baselines have evolved over time. This is important since these constitute the starting point for mitigation efforts. Continuously, we selected all scenarios with cumulative CO_2 emissions below 1600 Gt CO2 for the 2010-2050 period, which includes all scenarios staying below 2ºC temperature increase with at least 50% probability. We categorised them by publication year: AR5 covers scenarios published in the 2010-2014 period, SR1.5 in 2015-2018, and AR6 in 2019-2021 (all scenarios included in the SR1.5 database are excluded from the AR6 to avoid duplication). We compare inter-quartile ranges of various key indicators for climate mitigation and plot them as a function of cumulative 2010-2050 global CO_2 emissions from fossil fuel combustion and industrial processes. Using full-century climate diagnostics from the same databases, we link cumulative emissions to end-of-century temperature probabilities.

3 IPCC Mitigation scenario analysis



4 Discussion and Conclusions

- Gradual evolution of mitigation scenarios to 2050 throughout the past decade, evolving towards:
  - Lower reliance on coal, bioenergy, nuclear and CCS
  - Higher electrification of end-uses combined with renewable-based electricity
  - Lower macroeconomic costs of mitigation
- Most important factor behind this evolution is likely the reduced costs of renewable electricity and electrification technologies, as well as the model capabilities to represent these.
- Analysis signals relevance of stakeholders and industry experts in the entire mitigation modelling process, keeping modelling assumptions up-to-date with rapidly evolving markets and policy priorities
- Analysis suggests modelled mitigation pathways should not be treated as prescriptive, since "optimal" low-carbon futures can change over time, with updated assumptions and model capabilities.

[1] IPCC Climate Change. "Synthesis Report: Contribution of working groups I. II and III to the Fifth Assessment Report." Proceedings of the Intergovernmental Panel on Climate Change, Copenhagen, Denmark (2014): 1-167.
[2] IPCC, 2018: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty.
[3] IPCC Climate Change 2022. "Mitigation of Climate Change: Contribution of working III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change.
[4] IPCC data https://www.ipcc-data.org/

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