

Balancing global sources and sinks means lower economic costs in the long-term without relying on net-negative emissions

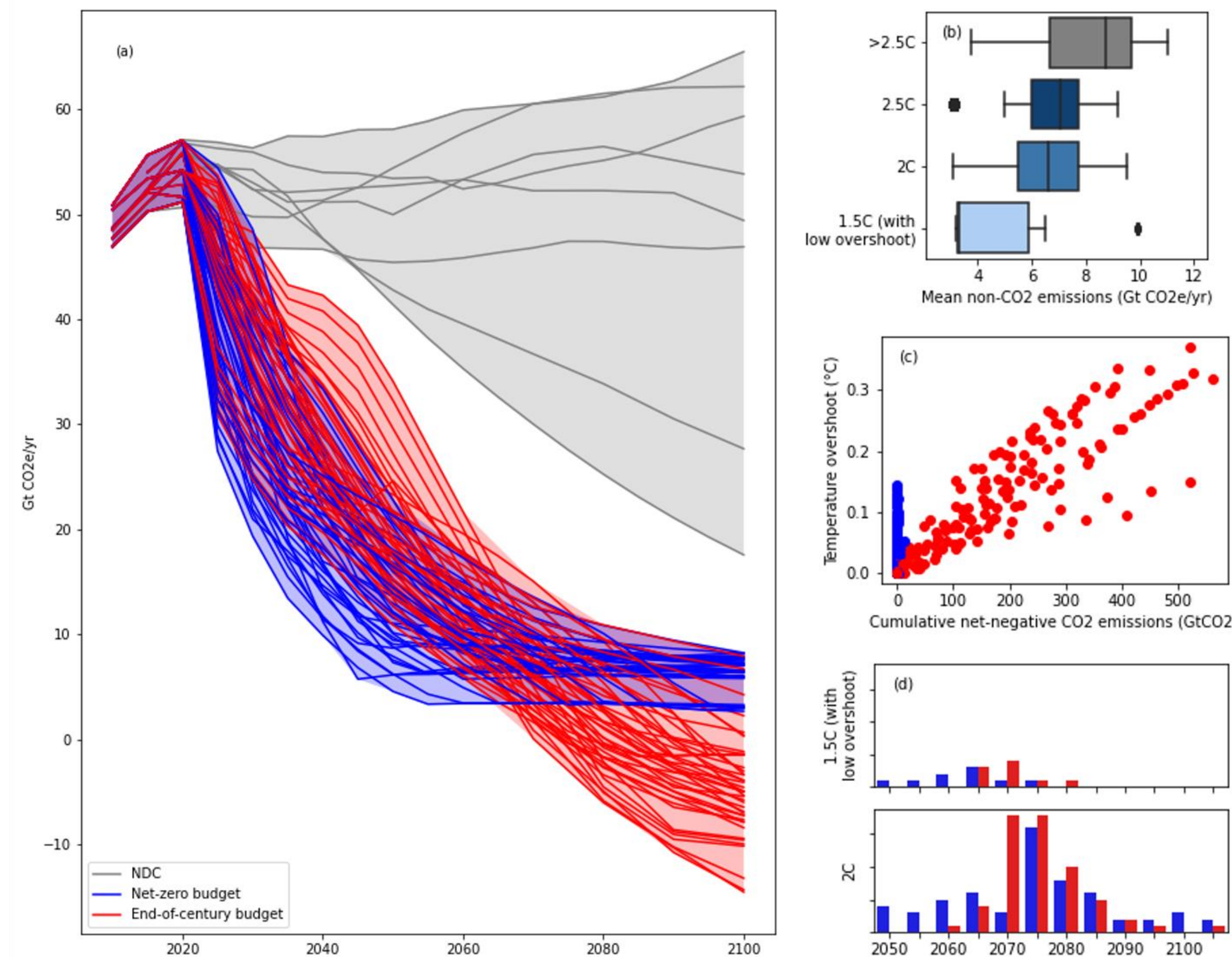
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Scenario design: No net-negative emissions

The new scenarios from the ENGAGE model-intercomparison adopt a new design (Rogelj et al, 2019) which:

- focuses on the remaining carbon budget in the near term until net zero CO₂ emissions are reached
- does not allow for any net negative emissions, thus exploring specific strategies that would keep temperatures below certain thresholds *without temperature overshoot*.

Global GHG emissions [Gt CO₂e/y]

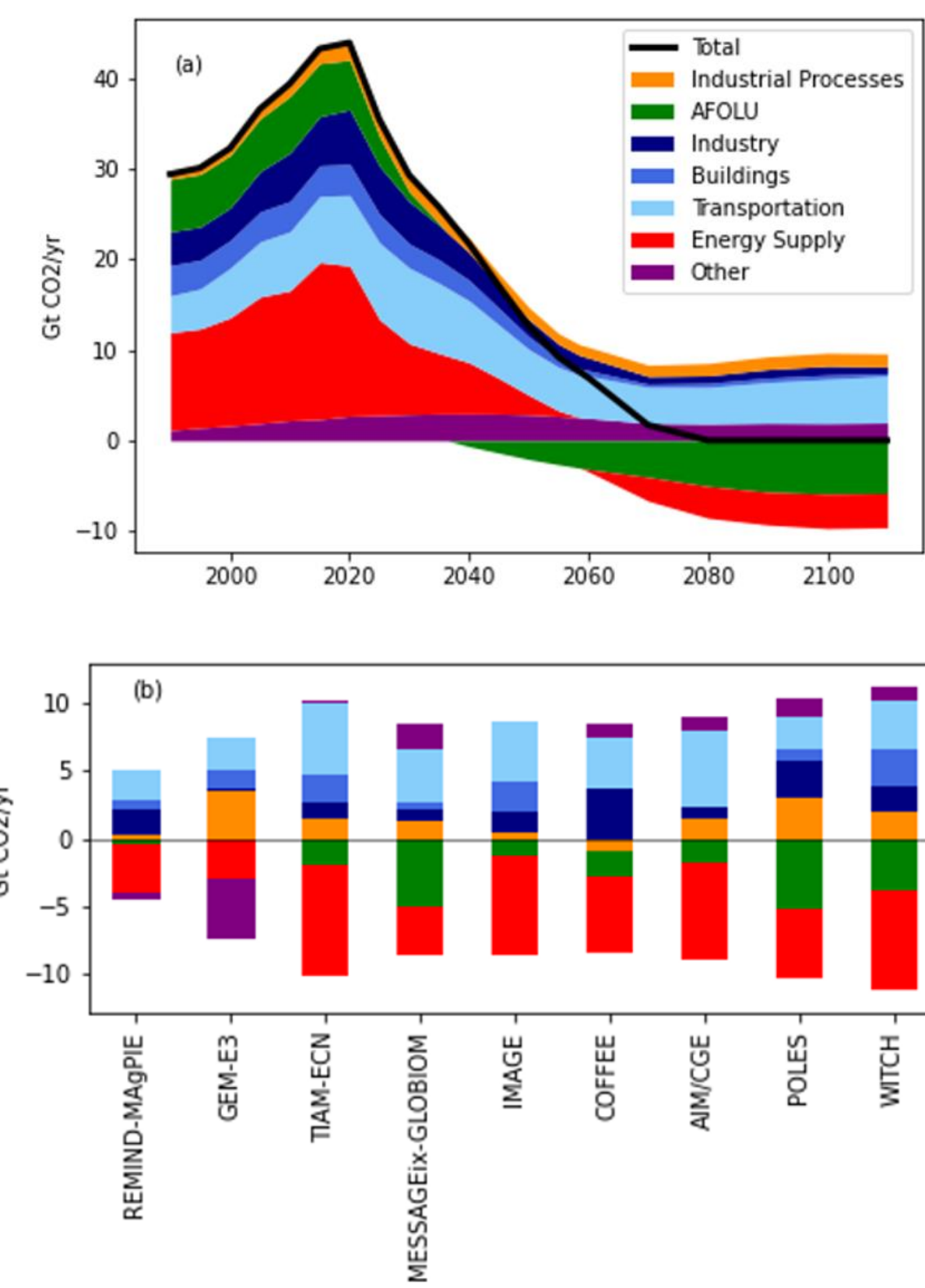


Left-hand panel (a): Development of emissions in scenarios consistent with keeping temperatures below 2°C with no net negative emissions (blue) and 2°C scenarios with overshoot (red).

Right-hand panels (b, c, d): Relationship between cumulative net negative emissions over the course of the century in order to bring down global average temperature (after peak/overshoot).

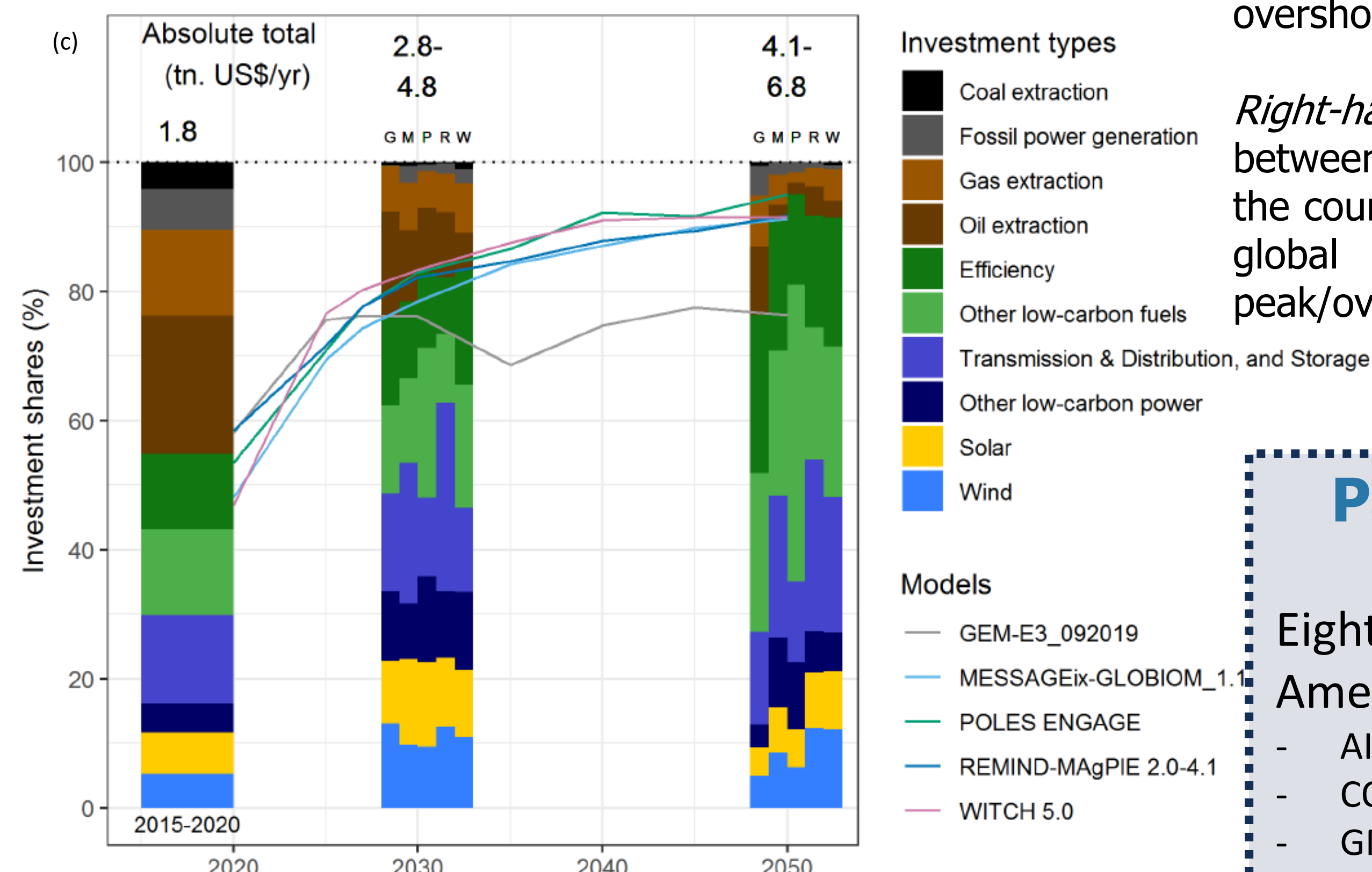
Key insights

- 1) Avoiding temperature overshoot requires more rapid and pervasive emissions reductions and a pronounced acceleration in the deployment of low-carbon energy portfolios in the near-term. Adaptive strategies may draw down temperatures in the long-term, but will require net negative CO₂ emissions or deep long-term reductions of non-CO₂ emissions.
- 2) Although more upfront investment is needed in scenarios without net negative emissions, this creates significant long-term benefits. Across all scenarios and models, there are net economic gains and higher long-term GDP levels compared to scenarios with large-scale negative emissions and overshoot. Our analysis indicates that at a discount rate of <2.5%, most models see cost-optimal mitigation strategies without needing negative emissions or overshoot.
- 3) A net zero emissions system comprises sectors that remain sources of positive emissions, while other sectors act as sinks. Nature-based solutions will be critical to enhance the biospheric sink and to allow energy production at negative emissions, while the industrial sector, transport and buildings may continue to emit small residual CO₂ emissions (2-10 GtCO₂ worldwide).



Left-hand panels (a, b): Development of emissions by sector and region in the MESSAGEix-GLOBIOM model over time under a 1000 GtCO₂ net-zero scenario and across different models at the time of reaching net-zero emissions.

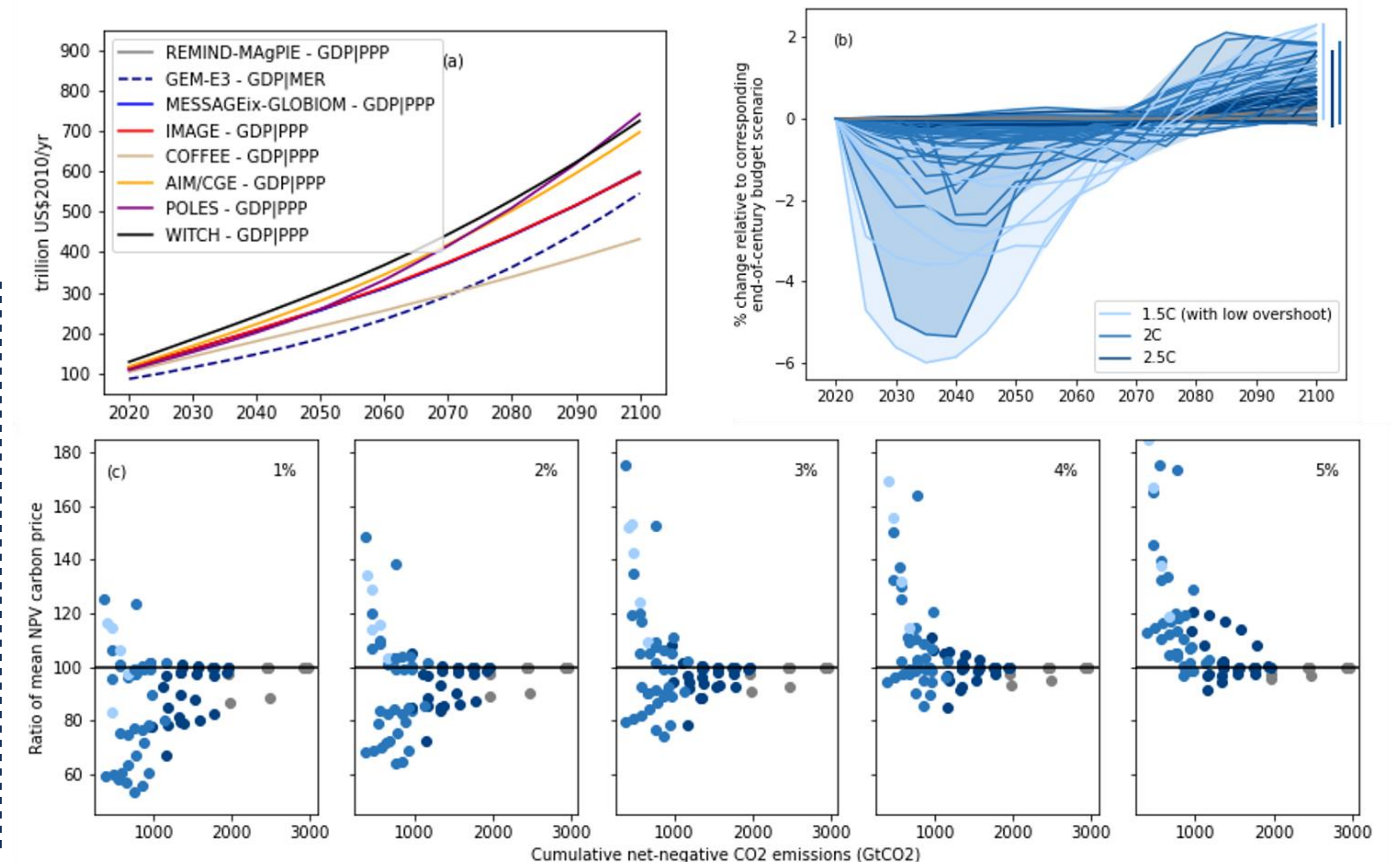
Right panel (c): Investment shares (bars), and share of non-fossil investment (lines) for all 600 Gt net-zero budget scenarios



Participants in the ENGAGE model comparison

Eight global modelling teams from Asia, America, and Europe:

- AIM (NIES/Kyoto University, Japan)
- COFFEE (COPPE, Brazil)
- GM-E3 (E3 Modelling, Greece)
- IMAGE (PBL, Netherlands)
- MESSAGEix-GLOBIOM (IIASA, Austria)
- POLES (JRC, European Commission)
- REMIND-MagPie (PIK, Germany)
- WITCH (CMCC, Italy)



This poster is based on: Riahi et al, (forthcoming), Bertram et al., (forthcoming)

Reference: Rogelj, J., Huppmann, D., Krey, V., et al. A new scenario logic for the Paris Agreement long-term temperature goal. 2019. *Nature* **573** 357-363.

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