Potsdam Institute for Climate Impact Research

Deep decarbonization for 1.5-2^{o}C climate stabilization

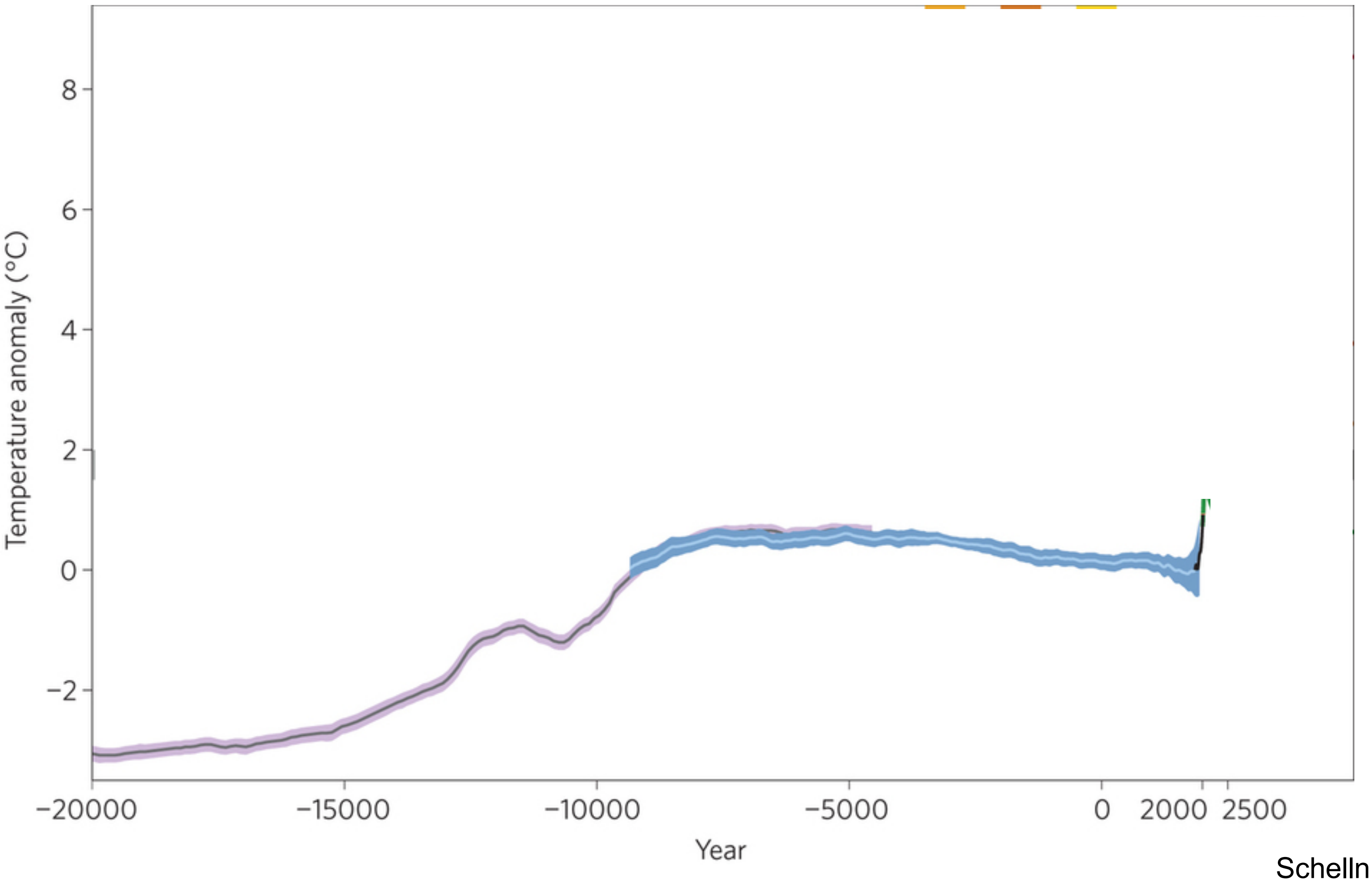
Gunnar Luderer

Based on work with Zoi Vrontisi, Christoph Bertram, Oreane Y. Edelenbosch, Robert Pietzcker, Joeri Rogelj, Harmen Sytze De Boer, Laurent Drouet, Johannes Emmerling, Oliver Fricko, Shinichiro Fujimori, Gokul Iyer, Kimon Keramidas, Alban Kitous, Michaja Pehl, Volker Krey, Keywan Riahi, Bert Saveyn, Massimo Tavoni, Detlef P. Van Vuuren, Elmar Kriegler

Leibniz Gemeinschaft

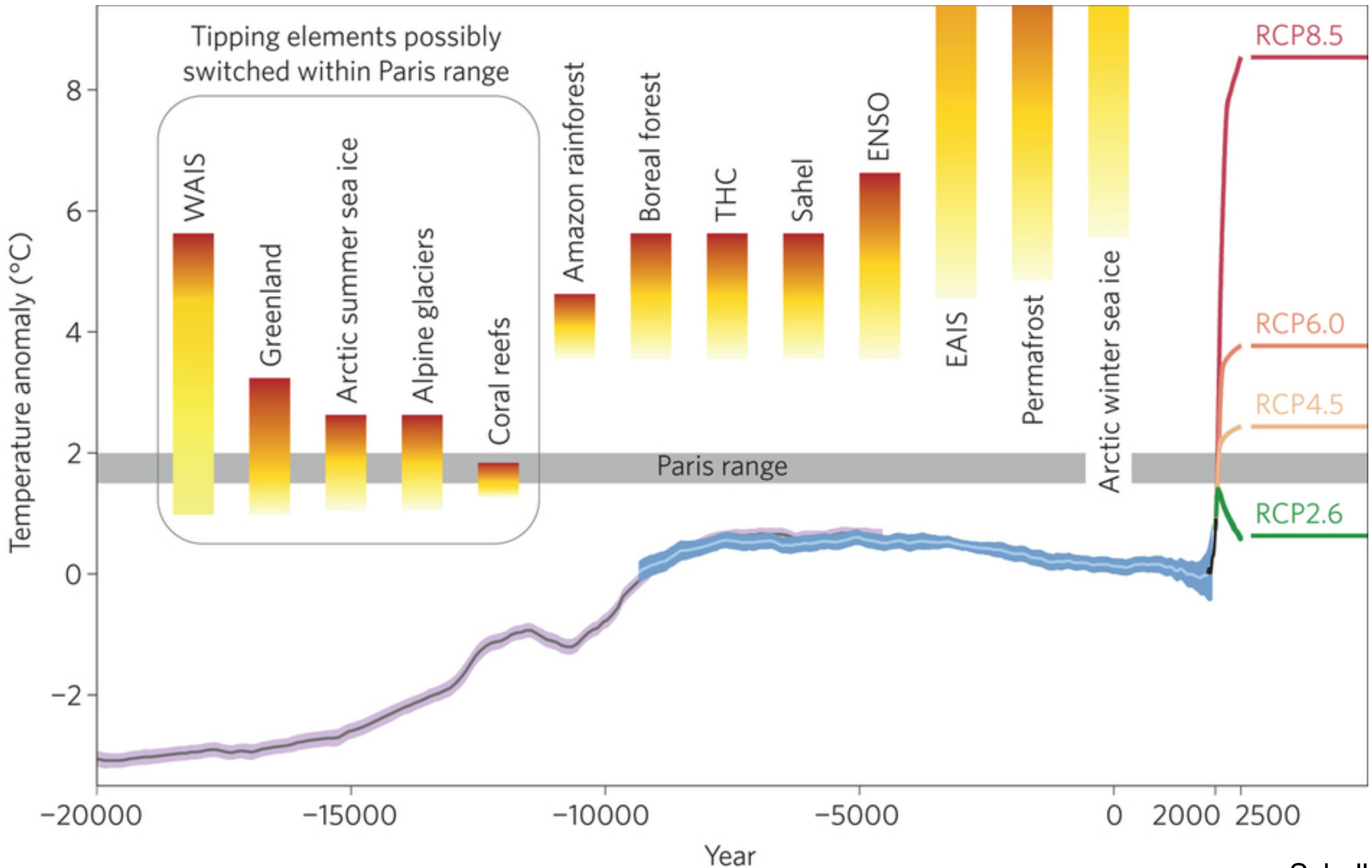
Based on paper in review
DO NOT CITE OR QUOTE

The case for well-below 2˚C stabilization



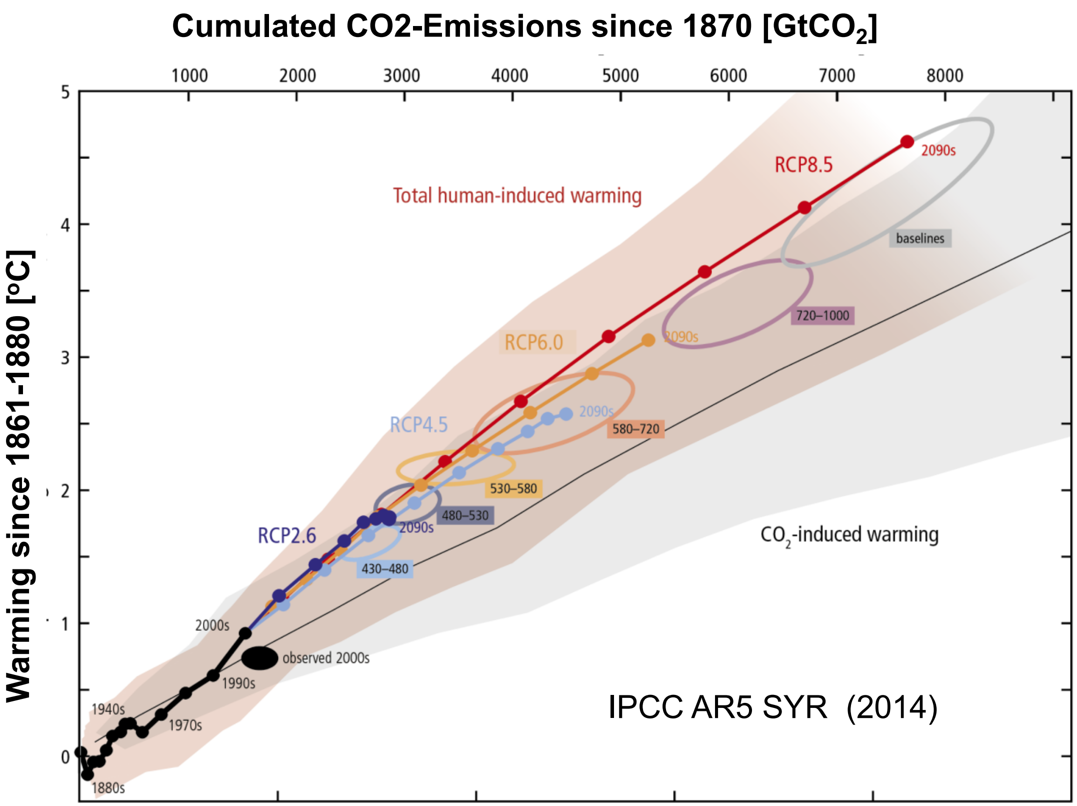
Schellnhuber et al. (2016)

The case for well-below 2°C stabilization



Schellnhuber et al. (2016)

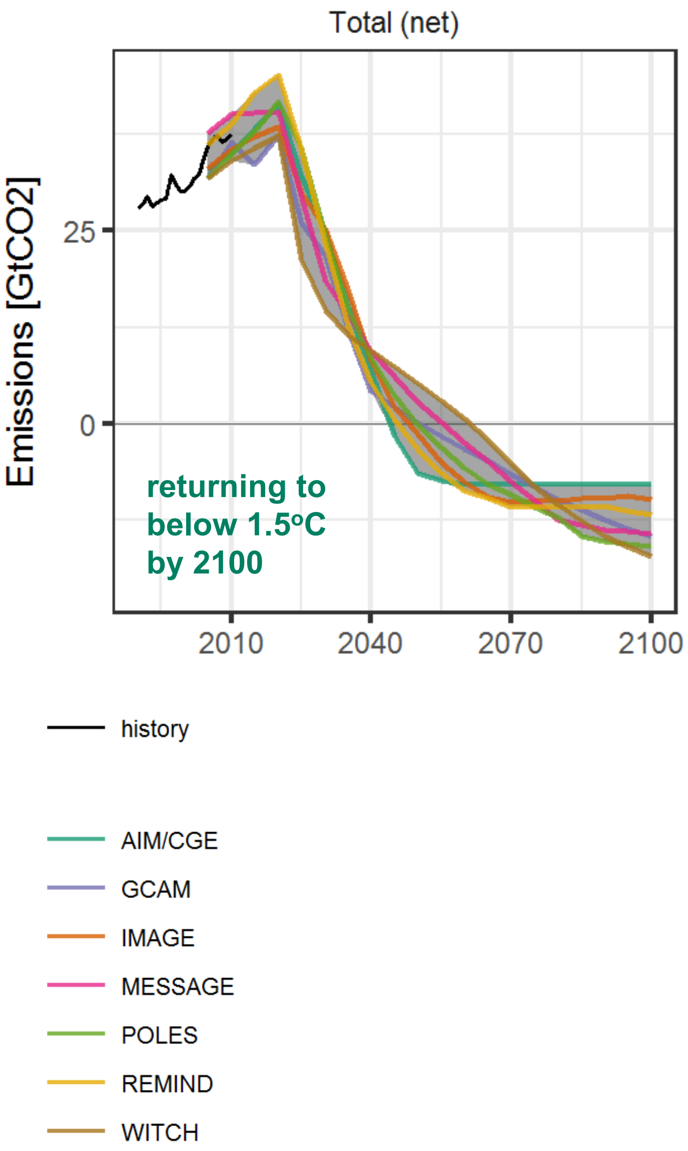
Warming is proportional to cumulative emissions



Global warming is roughly proportional to cumulative emissions

- There is a finite residual CO2-budget ca. 800 $GtCO_2$ for well below 2°C, and ca. 200 $GtCO_2$ for 1.5°C
- Emissions have to be reduced to near-zero in the long-term

Gross vs. net CO_2 emissions in 1.5°C pathways



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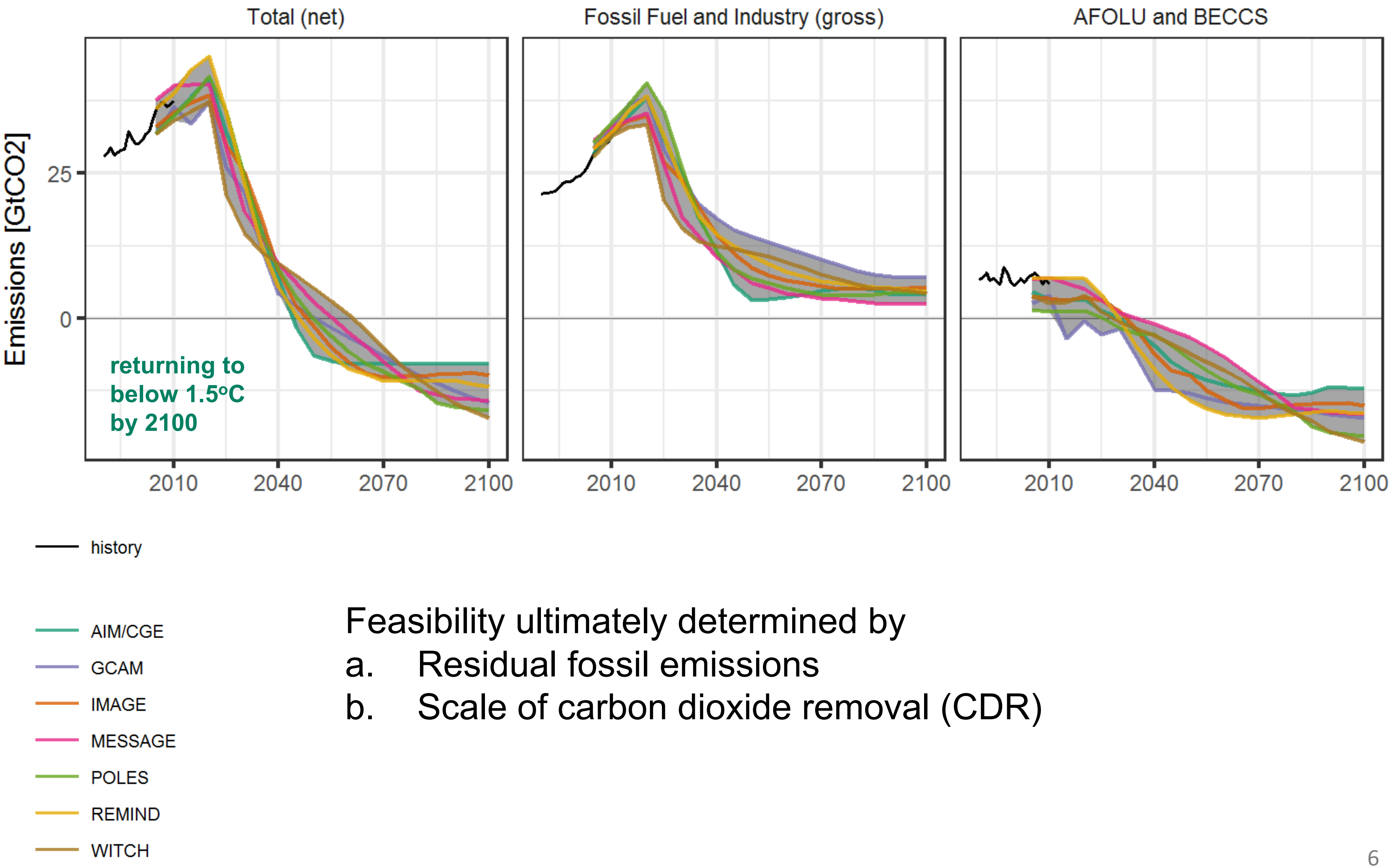
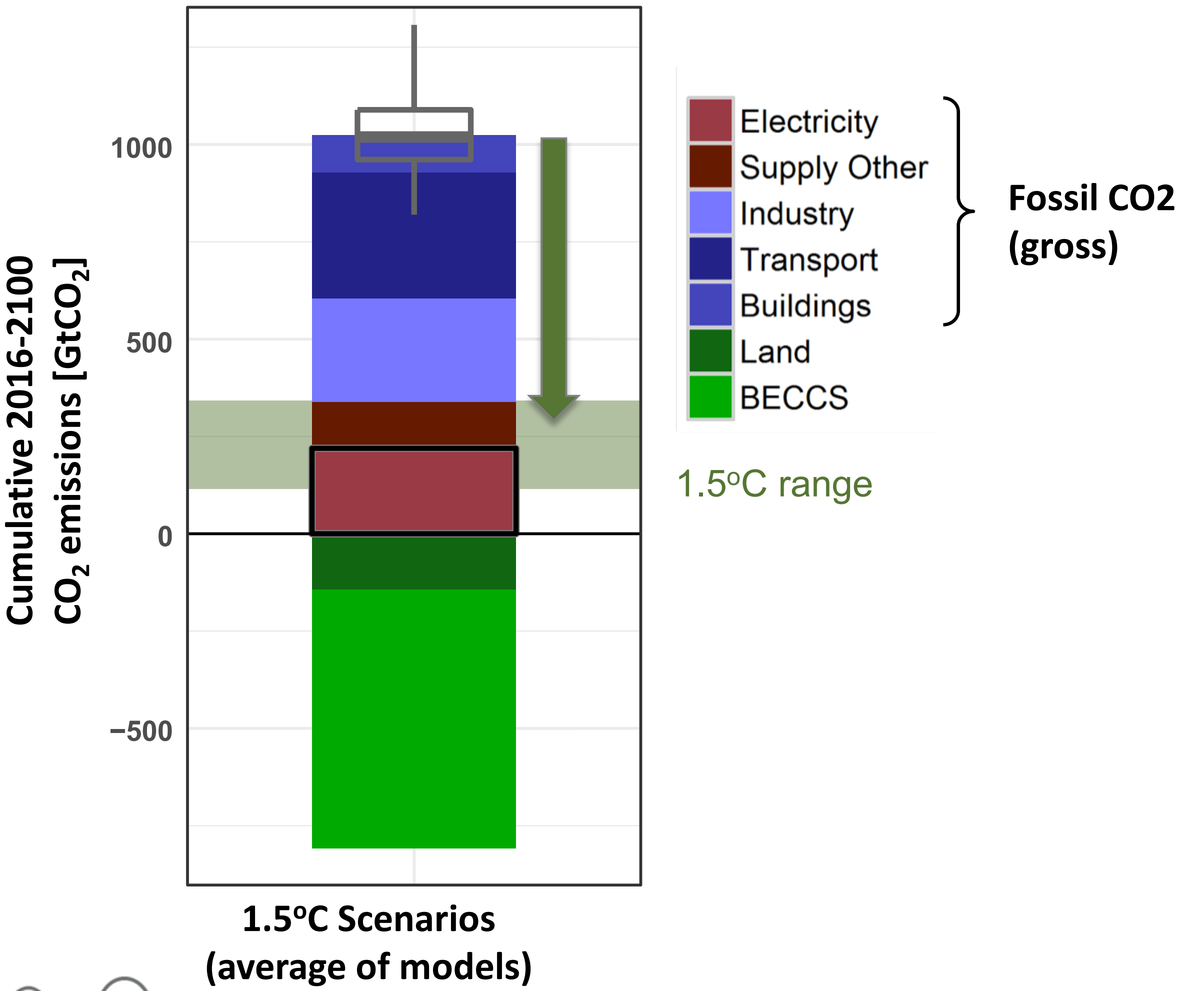


Feasibility ultimately determined by

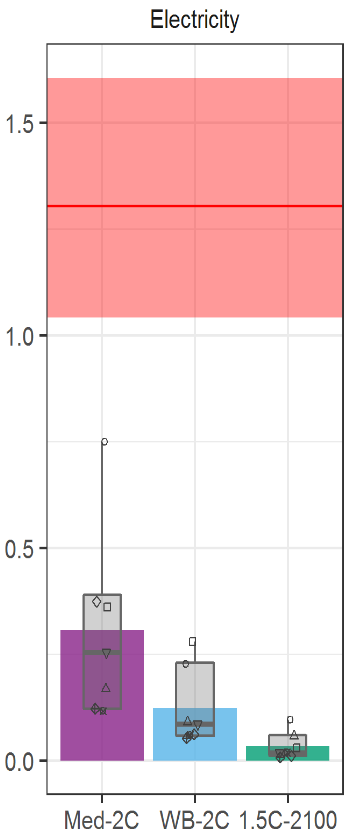
a. Residual fossil emissions
b. Scale of carbon dioxide removal (CDR)

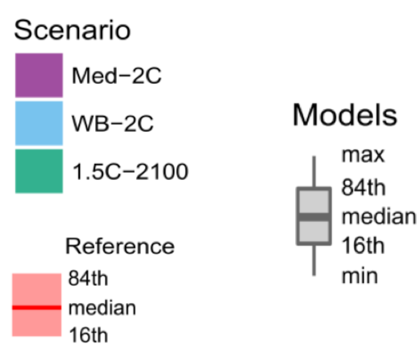
Sectoral breakdown



2050 emission reductions electricity vs. demand side

2050 CO_2 emissions normalized to 2010





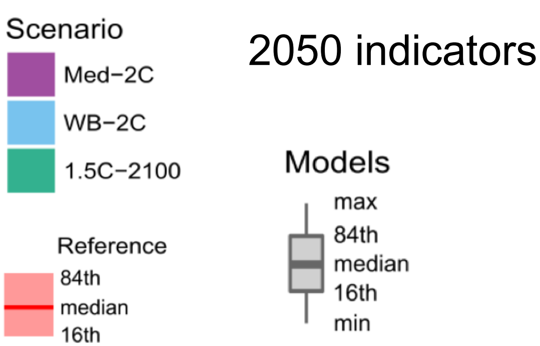
- Electricity supply is much easier and faster to decarbonize
- Most of the incremental effort for 1.5°C over 2°C comes from demand side

How can demand-side emissions be limited?

I. **Energy demand reductions (efficiency and sufficiency)**

II. **Reduction of combustible fuels (electrification)**

III. **Decarbonization of fuels (mostly biomass, hydrogen)**



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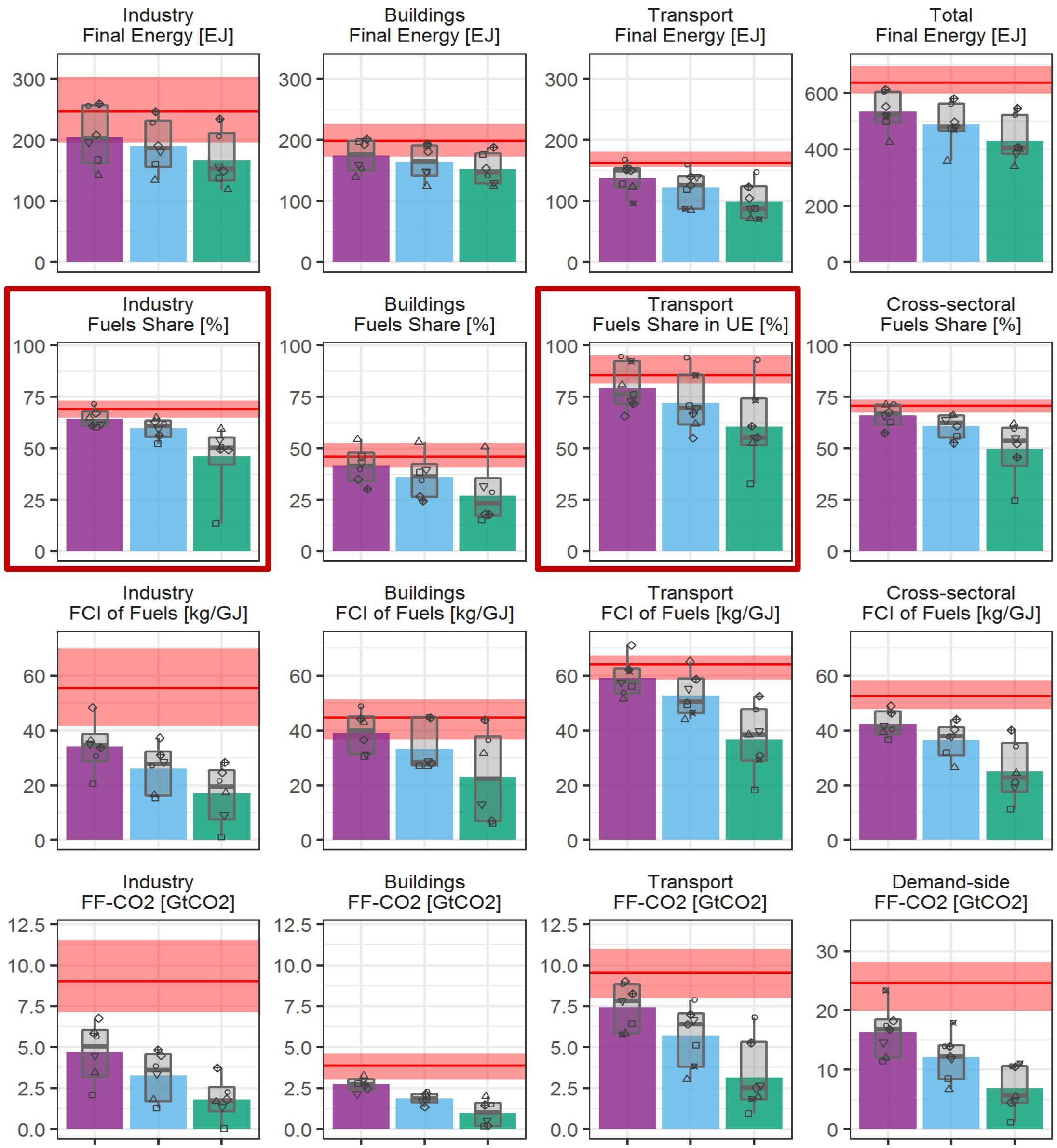

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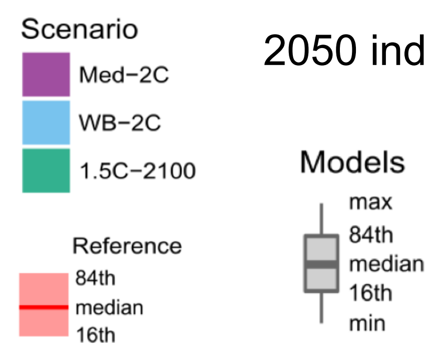
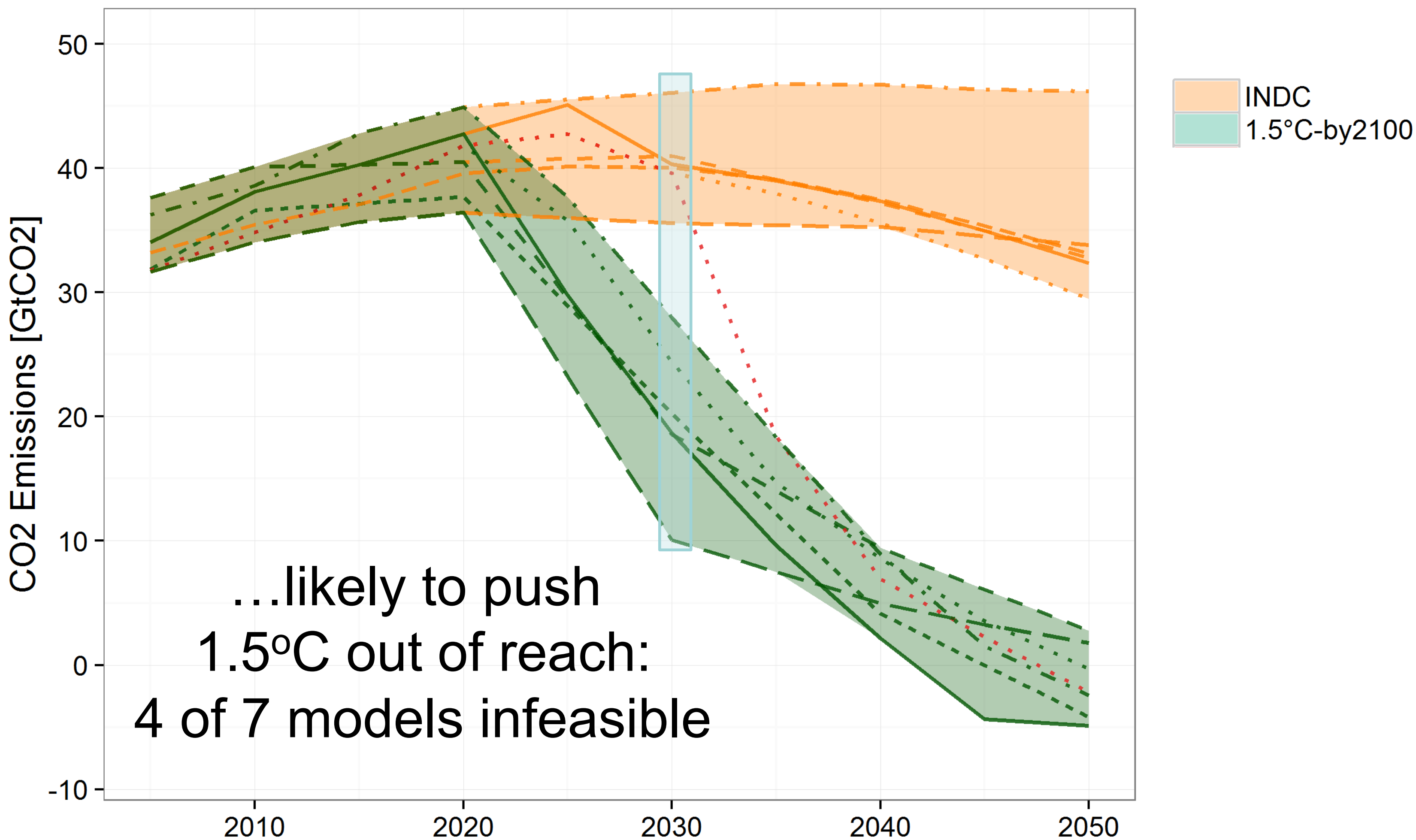
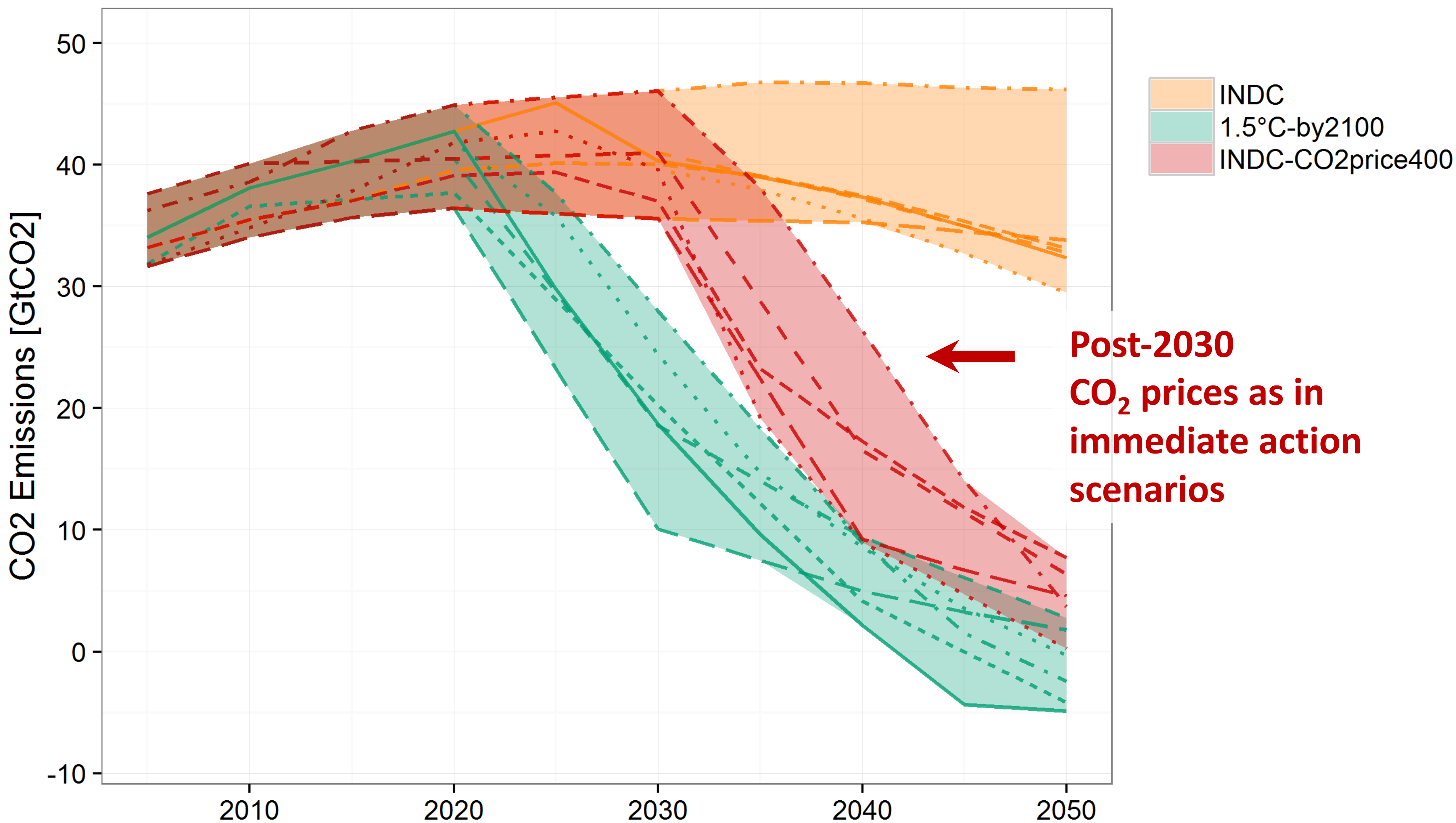


2050 indicators

Delay of strenghtening action…

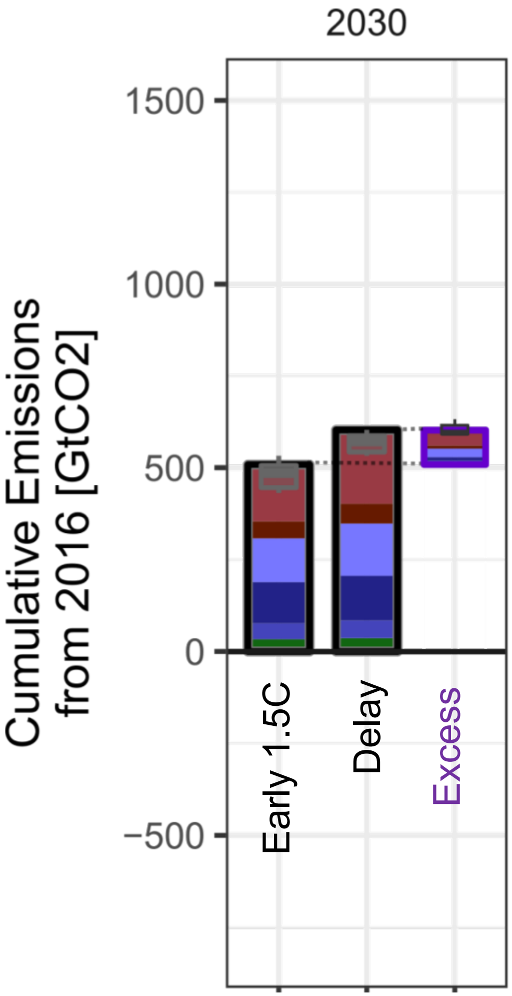


Delay of strengthening action

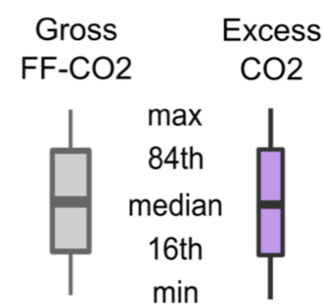


Post-2030 CO_2 prices as in immediate action scenarios

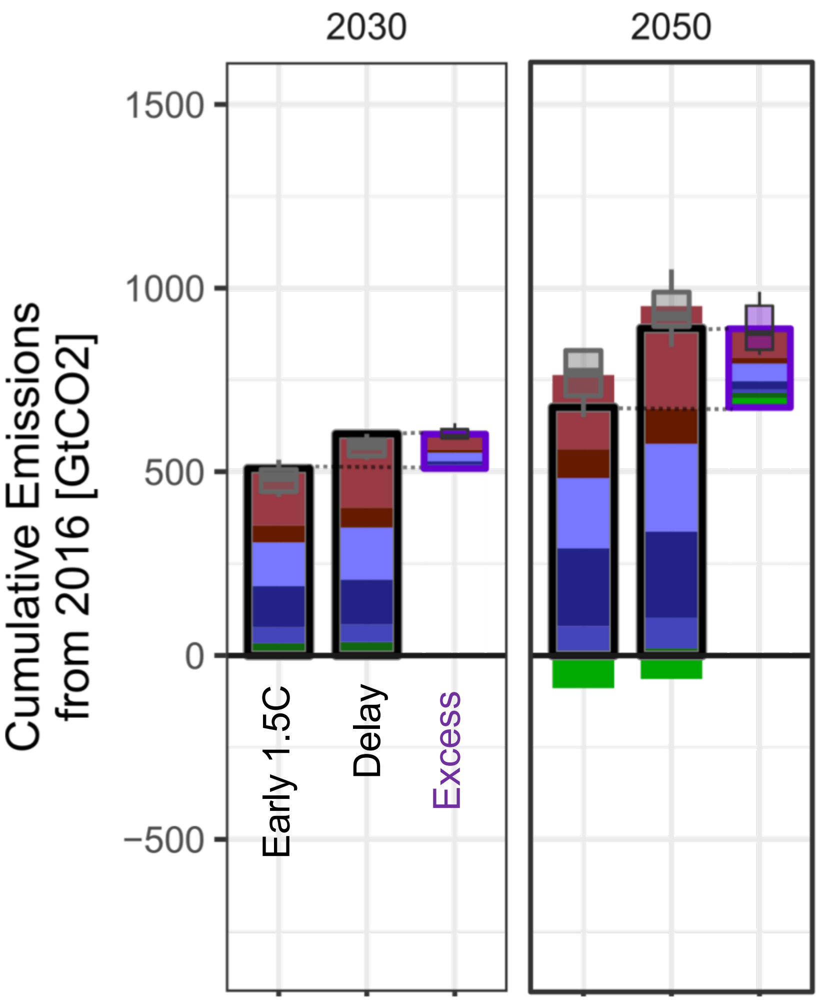
Impact of not strengthening before 2030



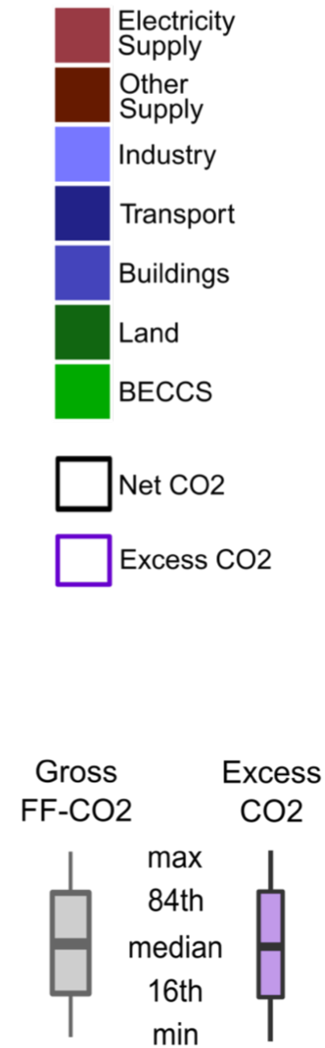
- 80 $GtCO_2$ of excess emissions in INDCs until 2030



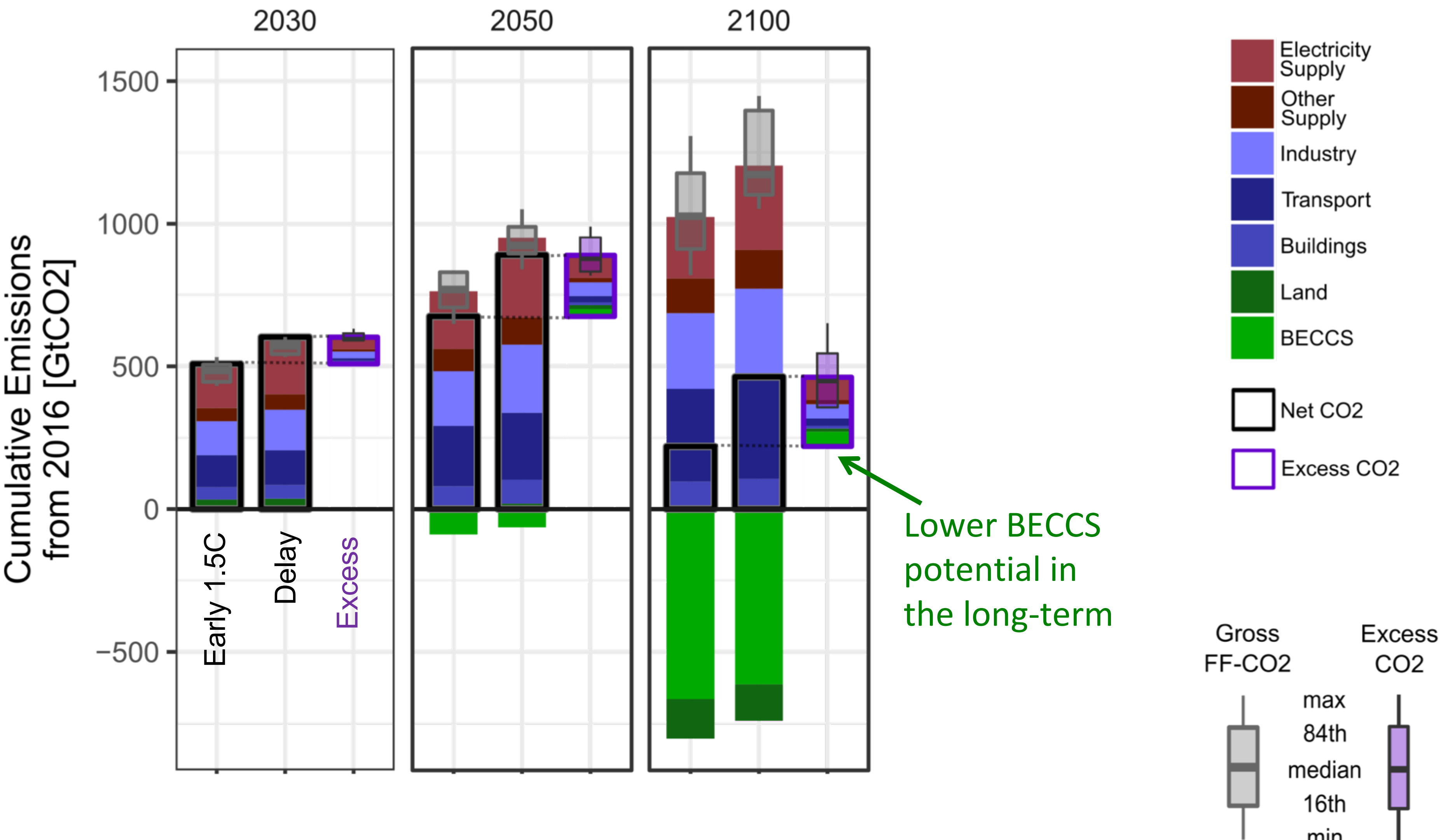
Impact of not strengthening before 2030



- 80 GtCO2 of excess emissions in INDCs until 2030
- Growing to 290 GtCO2 until 2100 due to carbon lock-in



Impact of not strengthening before 2030



Conclusions

- Achievability of 1.5-2^{o}C limits and their carbon dioxide removal (CDR) requirements hinge critically on residual fossil emissions from the energy system.
- Models suggest that ~1000 $GtCO_2$ might be a lower limit of these residual emissions, which is crucially determined by
  (a) The pace of decarbonization of energy supply and demand;
  (b) Innovation towards overcoming critical demand side decarbonization bottlenecks, such as freight transport, aviation, heavy industry;
  (c) Life-style changes towards less energy and material intensive consumption.
- 2^{o}C remains barely achievable without carbon dioxide removal.
  CDR is no longer a choice but rather a geophysical necessity for 1.5^{o}C.
- Not strengthening action before 2030 increases the lower limit of residual fossil CO_2 by around 290 $GtCO_2$, likely pushing the 1.5^{o}C goal out of reach.

Thank you!

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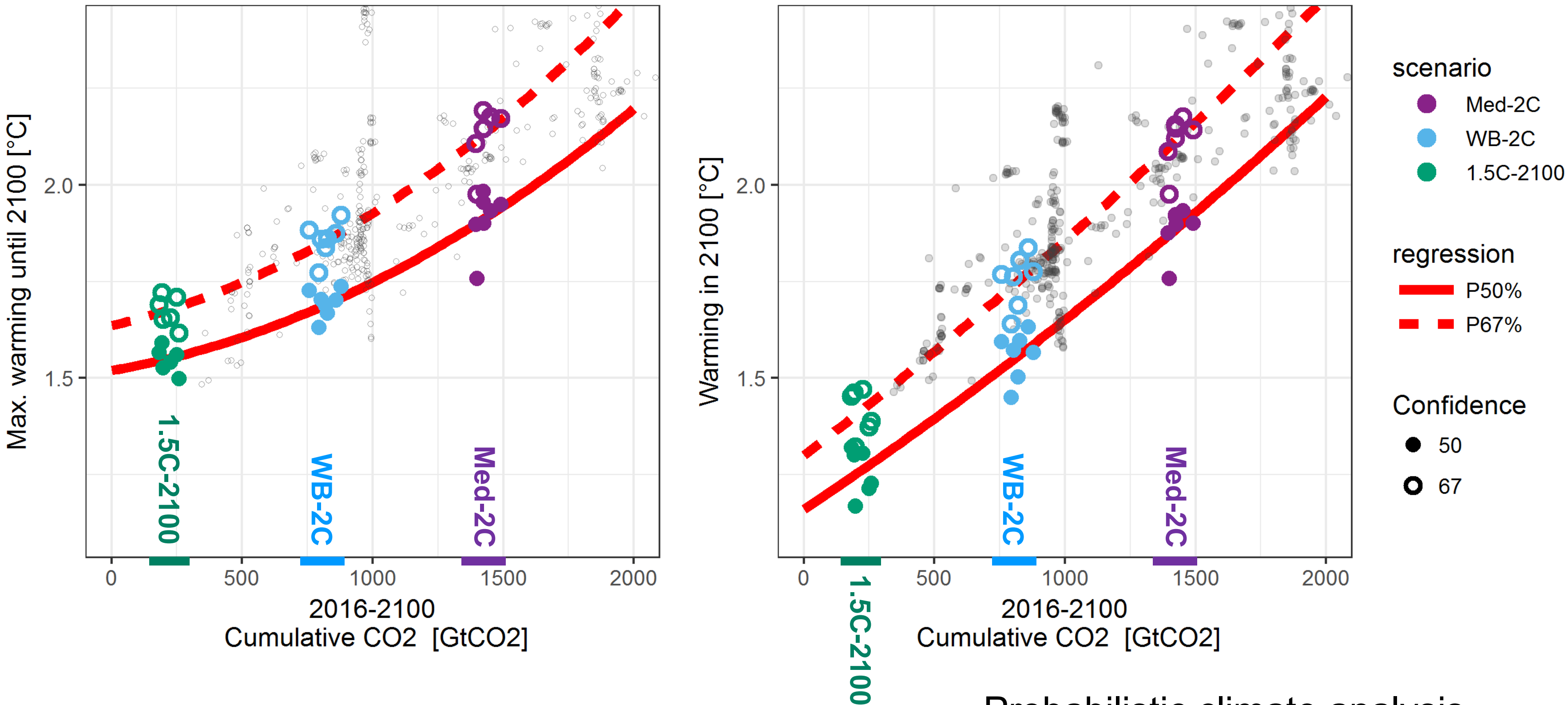
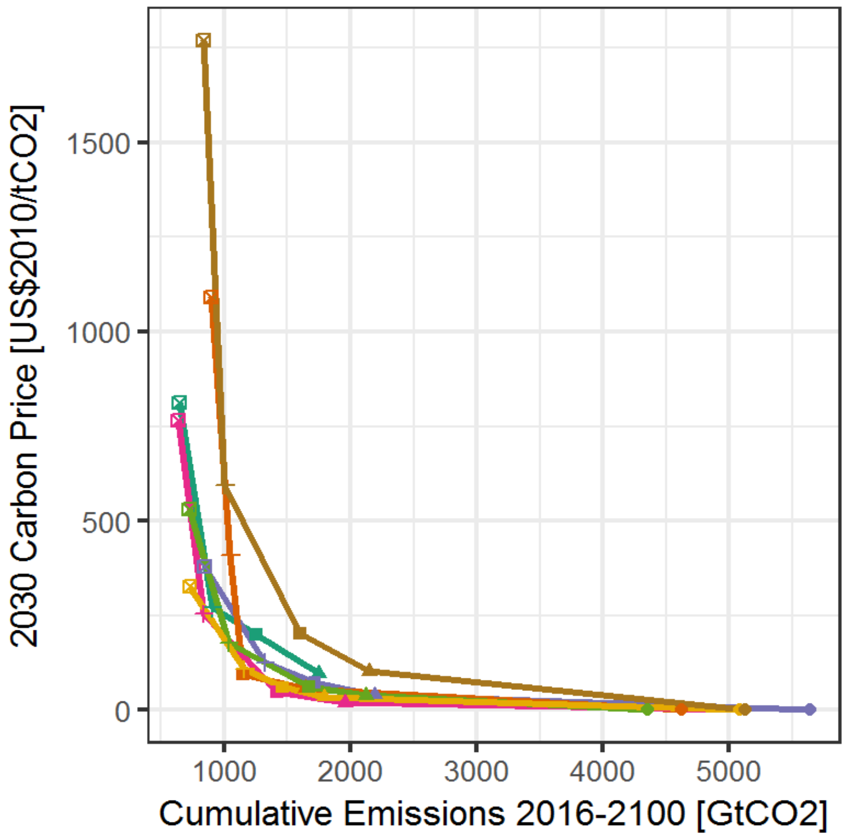
CO_2 budgets for 1.5 to 2°C

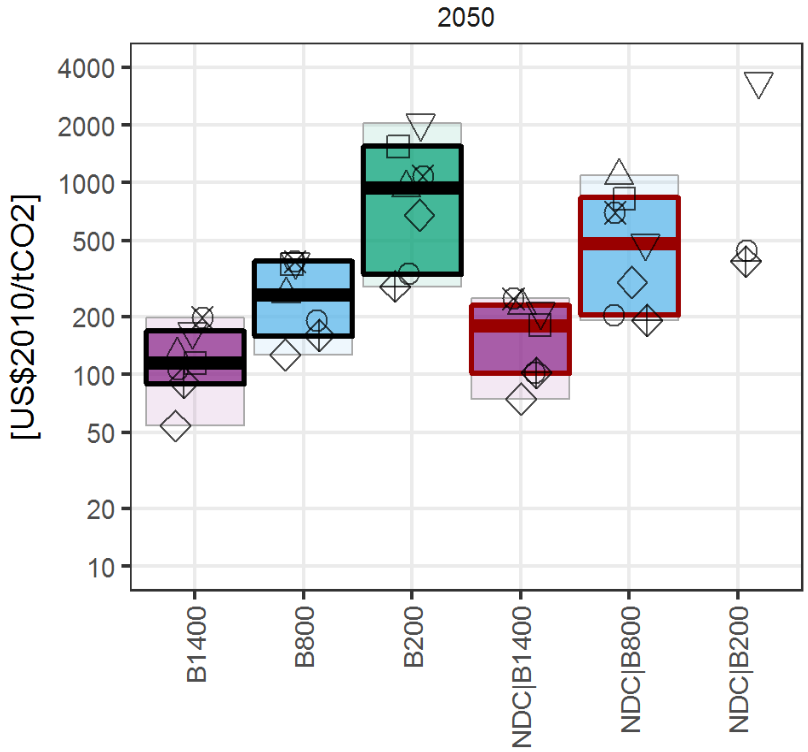


What determines the lower limit of CO2 budget constraints?

Probabilistic climate analysis with MAGICC model

Steeply increasing mitigation costs around 1.5°C





Electricity transformation