SCENARIOS FORUM 2022

Uncertainty in non-CO_2 greenhouse gas mitigation:

Make-or-break for global climate policy feasibility

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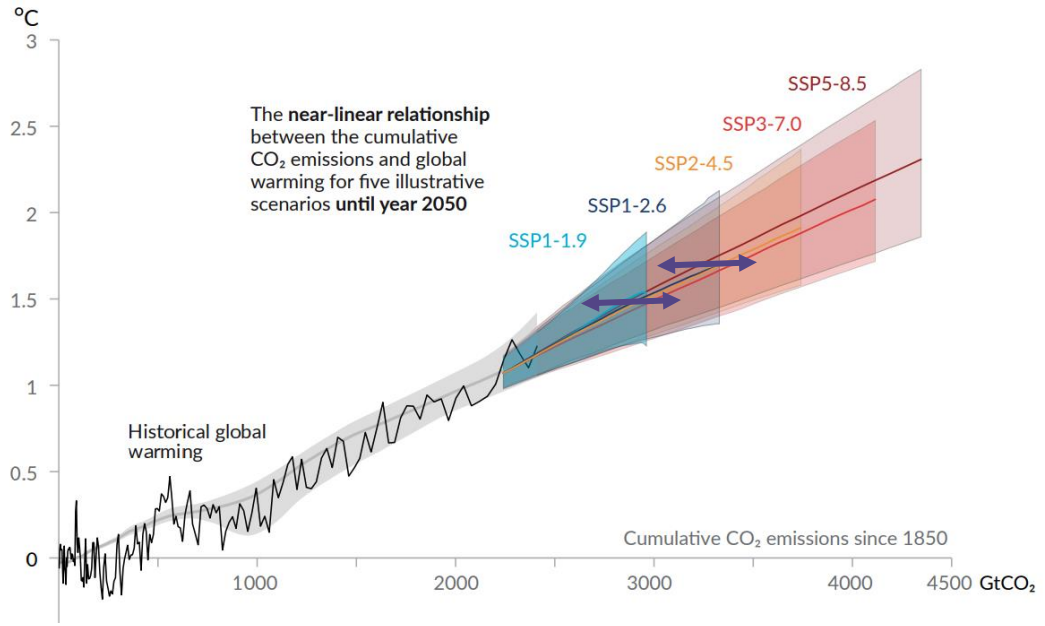
Introduction

- Key role for non-CO_2 GHG mitigation (ambitious targets and reducing costs)
- However, relatively little attention
- Global non-CO_2 projections are generally IAM-based and Marginal Abatement Cost (MAC) curve-based
- Problems with the current non-CO_2 MACs:
  - Produced by a small number of groups
  - Long term MACs are rare (and/or inconsistent)
  - MAC data in the models is often >10 years old
  - IAMs now only use “one” middle of the road estimate
- Uncertainties in mitigation potentials are inherently high, as are the implications; Under- or overestimations would strongly affect:
  - Feasibility of global climate policy
  - Climate policy costs
  - The need for CO_2 mitigation efforts / carbon budgets

This study

- First, systematic, bottom-up approach to assess uncertainty in long-term non-CO_2 mitigation (and costs)
- Approach in short:
  - Develop long-term marginal abatement cost (MAC) curves that incorporate uncertainty in non-CO_2 mitigation potentials
  - Assess implications in (IMAGE-SSP-based) scenario study, also taking into account uncertainty in human activities

- Alternative to top-down assessment of scenario databases
  - Changes in carbon budget due to non-CO_2 mitigation uncertainly
  - SR1.5: +/-250 Gt CO_2
  - AR6: +/-220 Gt CO_2
  - -> huge compared to remaining 400 and 1000 Gt budgets in 1.5 and 2 dC scenarios
  - However, unclear what underlies the range



From: AR6, SPM

“Optimistic”, default & “pessimistic” MACs

- Method: builds on Harmsen et al, 2019
  - But with optimistic + pessimistic MAC (based on Monte Carlo analysis)
  - And more literature (180+ papers) on mitigation measures

$$RP_{(t,r)} = TA_{(r)} * RE * IP_{(t)} * OVcorr_{(t,r)}$$

$$MRP_{(t,r)} = (RP_{1\,(t,r)} + RP_{2\,(t,r)} + RP_{3\,(t,r)} \ldots + RP_{x\,(t,r)}) * TP_{(t)} - Bcorr_{(t,r)}$$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Long-term marginal abatement cost curves of non-CO_2 greenhouse gases

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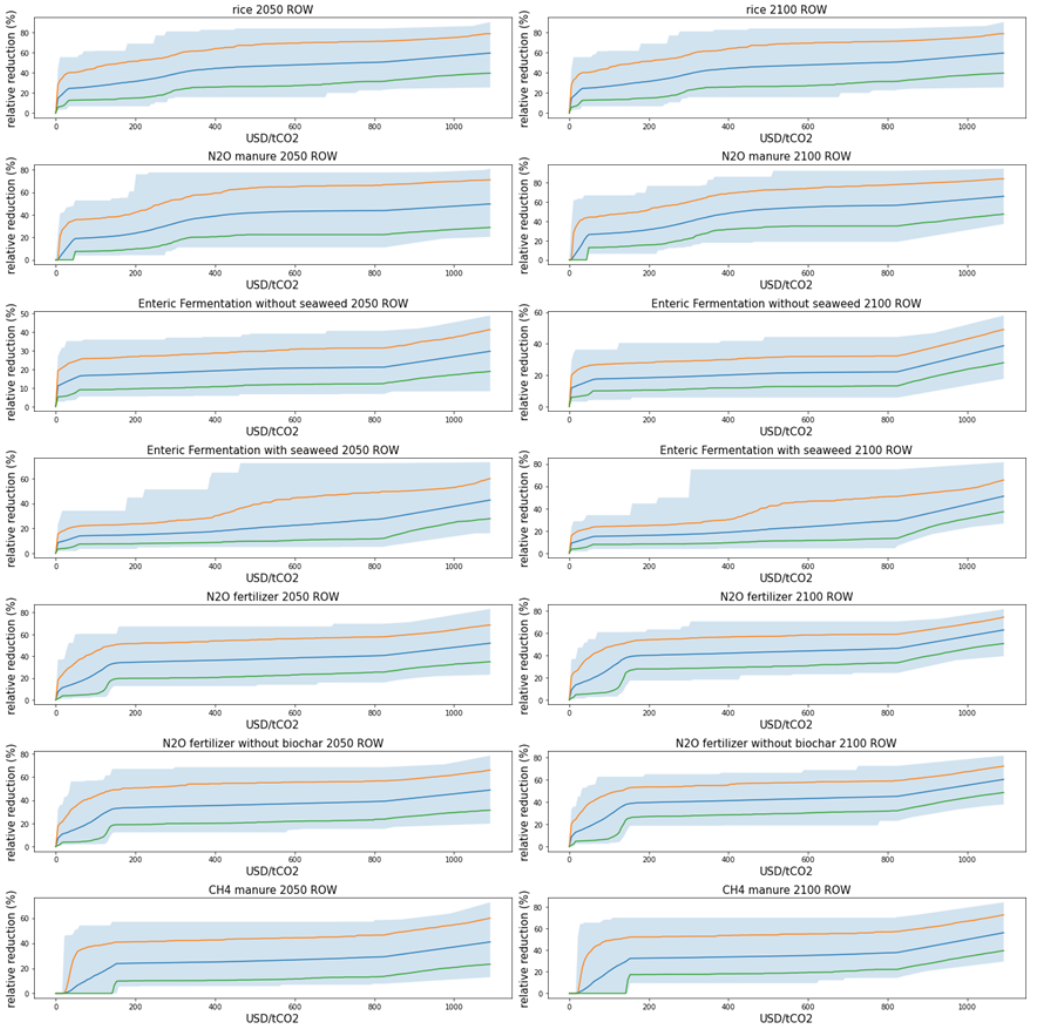
MACs built from components, representing:

- Technical applicability
- Reduction when applied
- Implementation potential (non-technical barriers)
- Overlap between measures
- Technological progress

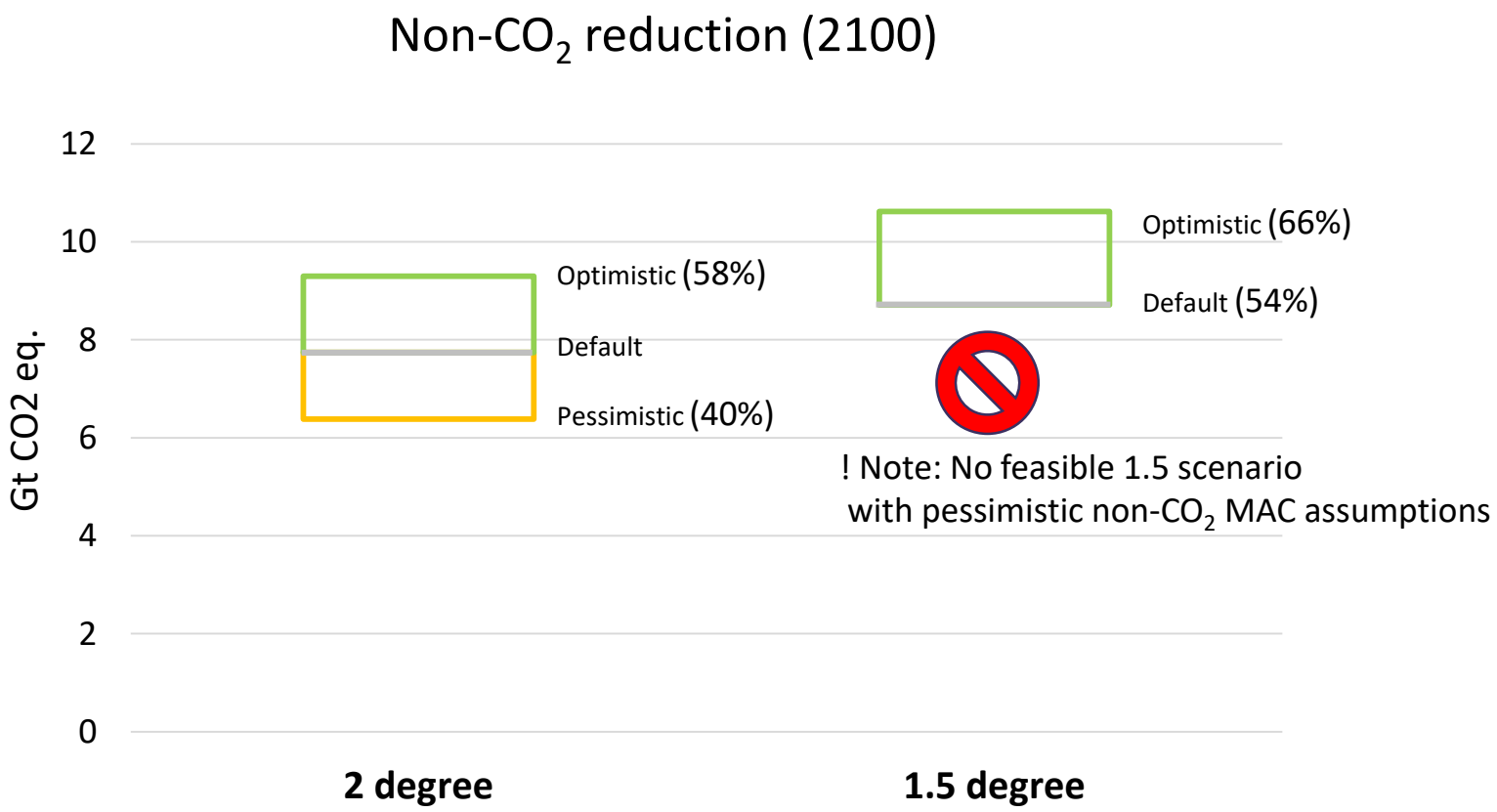
- Full Monte Carlo analysis (varying component values) for agricultural sources (CH_4: enteric fermentation, manure, rice | N_2O: fertilizer, manure)
- Because: Hardest-to-abate, uncertain & most detail in prior study
- Ranges set based on literature and insights GAINS
- 1000 runs – MACs: 5th, 50th, 95th percentiles
- More aggregated approach for fossil, industry, waste and F-gases:
  - Existing datasets + assumptions on long term maximum reduction potentials



Scenario results

- MAC uncertainty → Non-CO_2 reduction uncertainty:
  - 40% - 58% (2dC)
  - 54% - 65% (1.5dC)

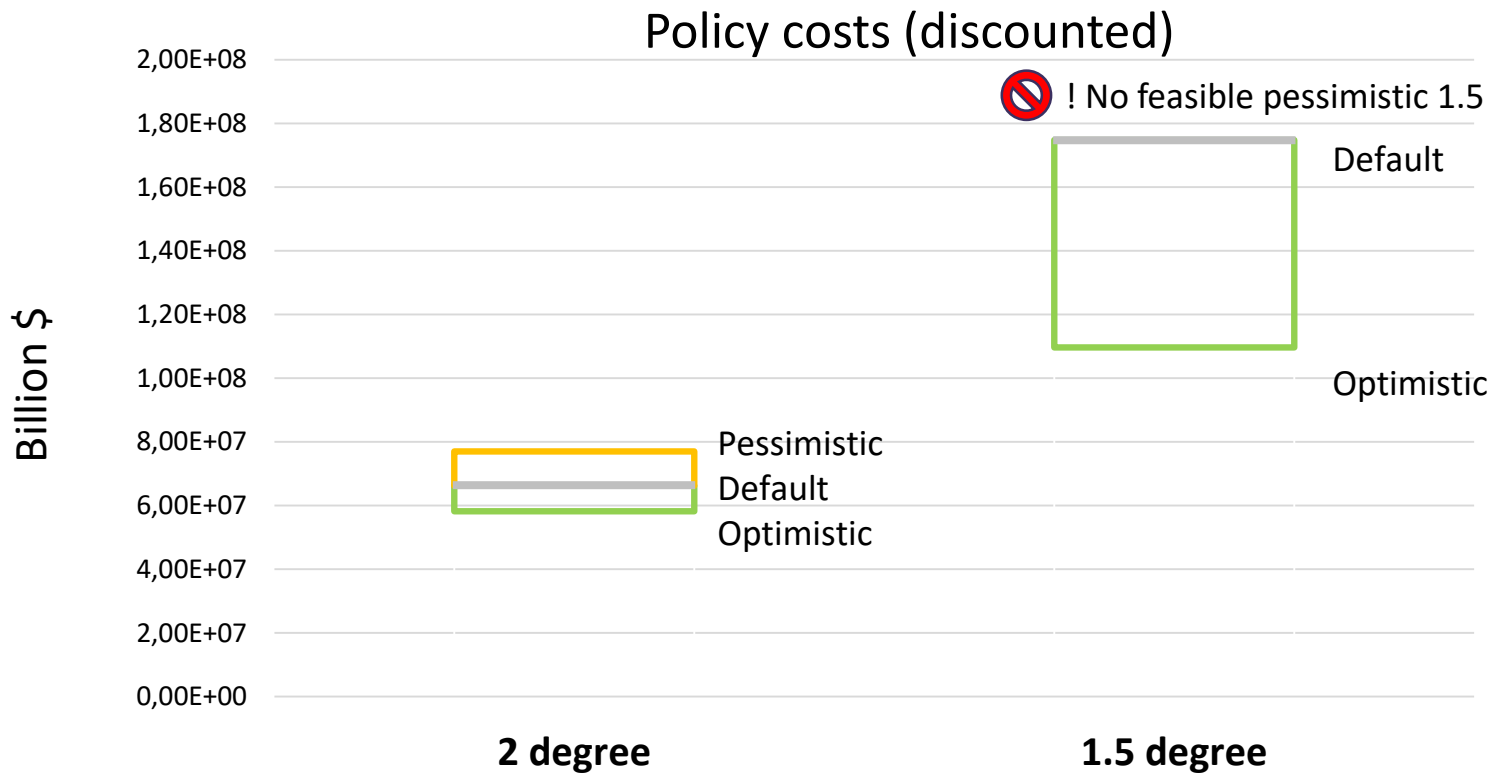
- High low 2100 forcing difference (W/m^2) in 2dC:
  - CH_4: 0.08
  - N_2O: 0.05
  - F-gases: 0.02



Scenario results

Climate policy costs:

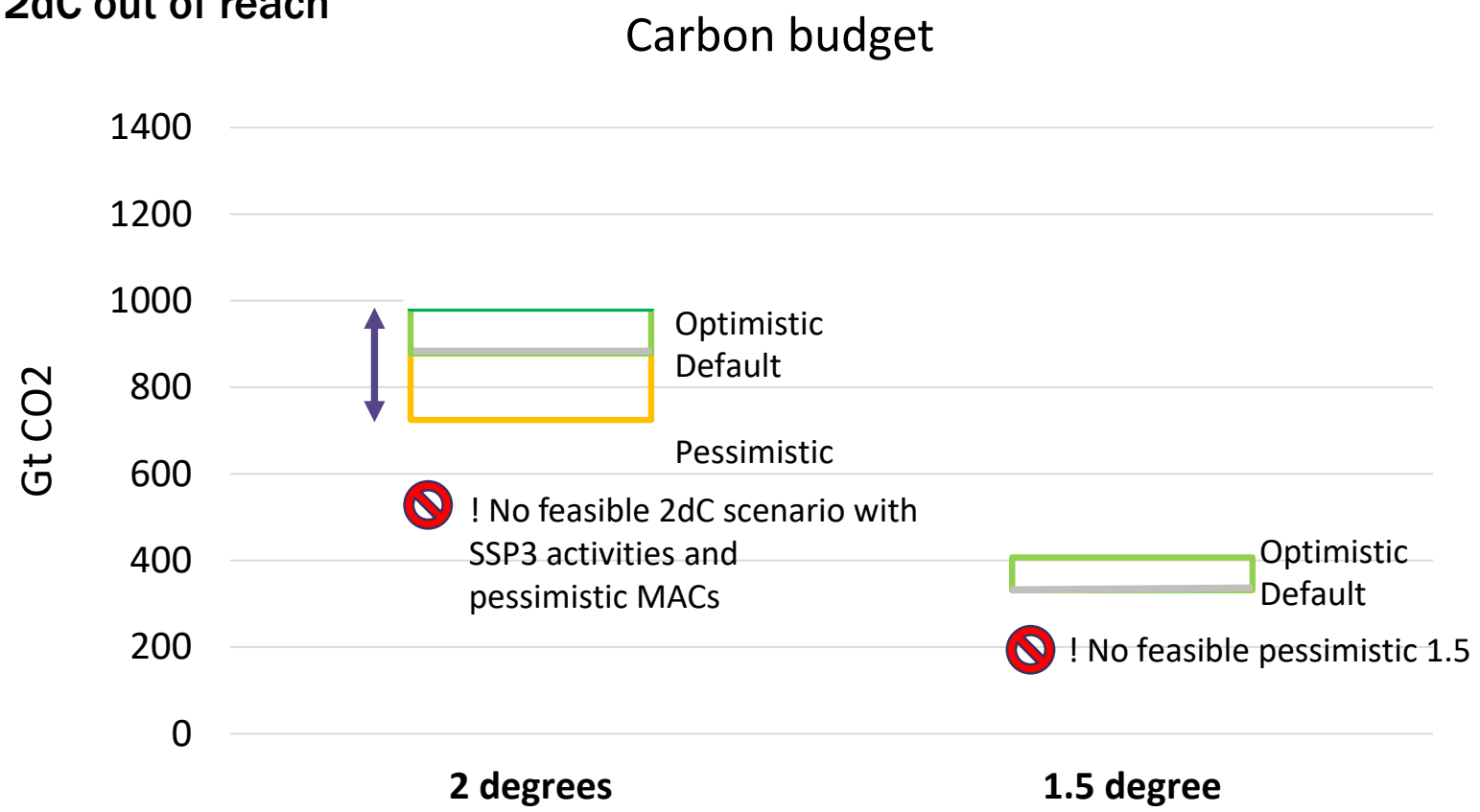
- 32% - 59% difference between optimistic and pessimistic



Scenario results

Carbon budget

- 260 Gt range in carbon budget due to MAC uncertainty in 2dC case
- 180 Gt CO2 additional in case of SSP1 activities
- Pessimistic + SSP3 activities: 2dC out of reach



Conclusions

- Non-CO_2 MAC uncertainty can have massive implications for climate policy feasibility:
  - 1.5dC target out of reach with pessimistic non-CO_2 MAC assumptions
  - Non-CO_2 relative reduction potential could vary between 40% - 66%
  - Carbon budget high-low difference: 260 Gt CO_2 (2dC)
  - Climate policy costs could vary 32% (2dC) – 59% (1.5dC)
- Uncertainty is even larger considering human activities:
  - 180 Gt CO_2 budget gain with SSP1 assumptions and optimistic MACs
  - 2dC out of reach with SSP3 assumptions and pessimistic MACs

Discussion points

- Partly, the uncertainty gap could be bridged by human efforts, but largely it indicates uncertainty in technical limitations
- Unknown parameter ranges remain subjective, however compensated with high Δ values, especially for costs
- Uncertain, non-included factor: wetlands
- F-gas uncertainty seems to be a small factor -> even pessimistic means large reduction

- Optimistic/Default/Pessimistic MACs are now available: https://www.navigate-h2020.eu/navigator/apply/

Questions?

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