

Editor comments

Source: https://editor.copernicus.org/GMD/ms_records/egusphere-2025-3546

I appreciate the for the further revision efforts by the authors.

Thank you for your careful review and insightful comments on our manuscript. We greatly appreciate your time and suggestions.

Further to ref #1's comments on model realism: From eyeballing your baseline electricity results (Fig 8) and policy-baseline difference (Fig 14), it seems that significant fossil-based electricity generation remains in the net-zero scenario. How are these emissions compensated?

We would like to clarify that the model does not impose an explicit net-zero emissions constraint on the electricity sector alone; rather, the net-zero target is applied at the level of the entire economy. As a result, some sectors, including electricity, may still exhibit positive emissions, provided that these are offset by net negative emissions in other sectors.

As shown in the updated Figure 14, in the "Policy" scenario for 2050 there remains a certain amount of fossil-based electricity generation (mostly gas). In this case, FF-based electricity generation exceeds biomass with carbon capture and sequestration (BECCS) within the electricity sector itself. However, the model deploys substantially more BECCS in other sectors (e.g., refining), which generates additional negative emissions. These compensate for the remaining positive emissions from electricity generation and allow the economy as a whole to meet the net-zero target.

I suggest the authors display absolute results (not differences to baseline) in section 4, since those are much more more relevant for assessing the applicability for policy analysis than the differences to a highly uncertain baseline.

Thank you for this helpful suggestion. We agree that presenting absolute values for the Reference and Policy scenarios can provide a clearer perspective for policy analysis. Following your recommendation, we have modified the top panels of Figures 13–15 to report absolute values for both scenarios at the EU and non-EU aggregate levels for selected years (2015, 2030, 2050, and 2100). We believe this addition helps contextualize the magnitude of the outcomes and facilitates a more direct interpretation of the results for policy purposes.

For the lower panels, which present country-level results, displaying absolute values for both scenarios would require two bars per country. In practice, this made the figures overly crowded and significantly reduced readability. To maintain visual clarity and allow differences across countries to be easily identified, we therefore retain the presentation of deviations from the baseline for the country-level results. Overall, we believe that combining absolute values at the

aggregate (EU/non-EU) level with differences at the country level provides a balanced and interpretable presentation of the results.

We note that Figure 11 now includes CO₂ from land-use change (CO₂_LUC), which we believe provides additional valuable information for the manuscript.

I would also ask the authors to more critically reflect on limitations of their model (and need for further validation) in the discussion section.

We added a new paragraph in the discussion section reflecting critically on the model and what came out of the current validation, while advising users how to use and interpret model outcomes:

"While GCAM-Europe improves the model accuracy and relevance to European stakeholders, the predictive capacity in absolute terms should not be overestimated. The validation exercise (Table B1) shows that even in historical years there are minor, though not always negligible, differences between the model and official EU statistics, especially at the country level, driven by structural simplifications in the model. Therefore, model results—and in particular country-level results—should be interpreted with consideration of these deviations, ideally focusing on relative changes. When modelling country policy targets for example, it is recommended to scale targets to historically observed values (Frilingou et al, 2026)."

Furthermore, we also acknowledge that some model behaviour may still seem unrealistic or insufficiently detailed, and that future model versions are expected to gradually improve this:

"Finally, the implementation of a stylised policy in GCAM-Europe, although useful to highlight the functionalities of the model, may still reflect behaviours that are not necessarily realistic across all examined variables and countries. Further validation is needed with more nuanced policy implementations that increase the real-world relevance of the model. This will also enable further stress-testing results with novel validation (Weigmann et al., 2025) and feasibility (Brutschin et al., 2021) assessment protocols. To this end, the model is planned to remain under continuous development, progressively integrating features from successive releases of the core GCAM model, while also further improving the detailed European representation of the model in future versions of GCAM-Europe to enable the implementation of more policy-relevant exercises."

Other notes (by Polina Shvedko): With the next revision, please re-label appendix tables according to our standards: <https://www.geoscientific-model-development.net/submission.html#manuscriptcomposition> > 7.

Following the editorial suggestions, we have restructured the appendices as follows:

- **Appendix A: GCAM-Europe regions** now includes **Table A1**, titled "*Overview of the GCAM-Europe regions and comparison with the core model.*" This table is now correctly referenced in the main text: "*These include the 27 Member States of the European Union (EU) and additional key non-EU countries (e.g., Switzerland and the United Kingdom) (see Table A1).*"
- **Appendix B: GCAM-Europe outputs** now includes **Table B1**, titled "*Comparison between GCAM-Europe outputs and historical data in 2015.*" The reference in the main manuscript has also been corrected: "*Table B1 shows that GCAM-Europe outputs for 2015 align reasonably well with historical data in terms of (fossil) CO₂ emissions, final energy (FE) consumption, and the share of renewables in FE use.*"