Editor comments

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

As per your introduction, you state that the GCAM-Europe as "a powerful tool for in-depth analysis of European climate policy at the member state level". To live up to that ambition, it needs to be better parameterized and validated for the European context. This is clearly not yet the case, for instance with respect to CCS assumptions and upscaling. It is absolutely unrealistic to have 400 MtCO2 of CCS by 2030, see e.g. the recent paper by Kazlou et al, and it would even be a very long shot to make this work for 2040. Assumptions on nuclear and renewable costs seem to be based on US context, not EU, which will distort power sector results. You indicate in your outlooks that you plan to implement an improved realization of real world policies, validation and feasibility assessments. Once these are conducted and the model is improved I can reconsider the paper.

The authors would like to thank the editor for the thorough feedback. We agree that, to demonstrate that GCAM-Europe is a powerful tool for analysing European climate policy at the Member State level, the application presented in Section 4 of the manuscript should demonstrate realistic technology deployment pathways and be grounded in the European policy context.

In the previous version of the manuscript, our aim was to present results from an illustrative "climate policy" scenario to demonstrate how the model responds to a simple policy shock and to verify that it behaves as expected, with increased deployment of different non-emitting technologies across European countries. The intention was to shed light on model dynamics rather than on the model's ability to represent real-world policy scenarios. In doing so, we implemented an economy-wide carbon tax that ended up significantly favouring certain technologies (e.g., BECCS), resulting in a pathway that was not fully aligned with existing policy plans or anticipated technological development pathways. Nevertheless, while the original scenario was intended purely as an illustrative example, we agree that unrealistic technology deployment pathways may distract from the main findings and lead to misinterpretation of results. In particular, although long-term projections (e.g., for 2050) are inherently more difficult to validate against current plans and expectations, unrealistic developments in the near term (i.e., by 2030) may hamper perceptions over the credibility of the scenario and the validity of the model itself.

Following the editor's recommendation, we have therefore completely revised Section 4. Rather than using a stylised carbon pricing scenario, we now present a policy-based scenario "*that incorporates both EU-wide policies, such as the Emissions Trading System (ETS) and vehicle emission standards, and country-specific measures, including coal phase-out commitments, nuclear phase-out and expansion plans, energy efficiency targets, and renewable energy targets as specified in each country's National Energy and Climate Plan (NECP). After 2030, a carbon*

cap is introduced that linearly reduces net CO2 emissions to zero by 2050". We believe that this revised scenario provides a much more appropriate demonstration of GCAM-Europe's capabilities for analysing European climate and energy policy.

All figures and the associated discussion have been revised accordingly. In addition, Table B2 has been updated to report both the EU ETS carbon prices and the post-2030 country-level carbon prices used in the scenario. Importantly, following the editor's suggestion, we explicitly compare GCAM-Europe projections against observed trends and published estimates of technology deployment and feasibility for biomass, CCS, and nuclear energy (Figure S13). The revised manuscript now states:

"*We also compare GCAM-Europe projections with available evidence on observed trends and estimated deployment potentials for biomass, carbon capture and storage (CCS), and nuclear energy (Figure S13). The projected expansion of biomass use, which is particularly pronounced in the NECP_LTT scenario, is slightly above observed consumption levels through 2025 but remains consistent with estimated sustainable biomass potentials. For CCS, GCAM-Europe projects only very limited deployment. Despite the implementation of climate policies, the NECP_LTT scenario projects only around 0.2 MtCO2 of CO2 sequestration by 2030, with emissions reduction targets being achieved primarily through the expansion of more mature renewable energy technologies. For nuclear energy, GCAM-Europe projects a slight decline in electricity generation by 2030 relative to 2015 under both the Baseline and NECP_LTT scenarios, with only minor differences between them. A modest increase in nuclear generation is projected in France and Slovakia, reflecting the finalization of new nuclear units expected by 2026–2027. However, this increase is offset by declining nuclear generation in other regions, most notably Germany.*"

Beyond the revisions to the model demonstration, considering that the extent to which we could deep dive into such a scenario was limited within a model description manuscript, we note that the policy representation implemented here is based on the same framework used in a separate application of GCAM-Europe that analyses four scenarios reflecting EU-wide (Fit-for-55) and national (NECP) climate policies (Frilingou et al., 2026). In addition, variants of these scenarios have contributed to international modelling exercises, including the State of CDR report (Gidden et al., 2026), following IAMC procedures and successfully passing the associated scenario vetting process.

Overall, we believe that these revisions directly address the concern regarding the realism of the illustrative scenario by replacing it with a policy-based scenario aligned with existing EU and national climate policies, revising all associated analyses, and incorporating explicit comparisons with published evidence on technology deployment and feasibility. While further improvements to parameterisation and automated validation remain ongoing areas of model development (as discussed in the Discussion section), we believe that the revised manuscript now provides a more robust and policy-relevant demonstration of GCAM-Europe's capabilities

for analysing European climate and energy transitions. We thank the editor again for this valuable recommendation and hope that the revised manuscript is now suitable for publication in Geoscientific Model Development.

Frilingou, N., Van de Ven, D.-J., Sampedro, J., Torné, A., Trutnevyte, E., Horowitz, R., Rodés-Bachs, C., Koasidis, K., Mittal, S., Xexakis, G., Nikas, A., 2026. Cost-optimal vs. policy-driven scenarios for a decarbonised European energy system. Environ. Res. Lett. 21, 034023. https://doi.org/10.1088/1748-9326/ae3f45

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