Editor comments

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

Thanks for providing additional figures in response to my earlier comments. These do, however, raise additional concerns.

The authors would like to thank the editor for their thorough evaluation and for the comments on our study. We address the specific comments below.

* how does the deployoment of bioenergy, CCS and nuclear until 2030 compare to real-world trends? Is such an expansion still technically feasible?

To offer a transparent reflection on the use of these decarbonisation options in the model, we added a comparison figure in the SI (Figure S13) which compares observed data and planned targets for bioenergy, CCS and nuclear use in the EU-27 based on the NECP targets. We observe that deployment in the Baseline scenario for GCAM-Europe is well in line with real-world trends, while, by contrast, implementing a stylized scenario in the form of a universal economy-wide carbon price significantly increases the share of BECCS and CCS and slightly decreases the use of nuclear, therefore departing from real-world trends in the Policy scenario. Arguably, it could be qualitatively inferred that the Policy scenario expansion seems to raise, at this point in 2026, technical feasible concerns. However, it is important to interpret the scenario from through the prism of the implementation of an economy-wide carbon tax from 2020 onwards, which primarily provides incentives for any CO2-saving activity, including BECCS. The results hint that the model responds well to this policy shock, by raising decarbonisation efforts. However, the path opted also reveals that simple economy-wide taxes when implemented alone in GCAM-Europe differ significantly from the real-world policy situation. This is an important insight for future model users who would want to reflect EU climate policy in more detail. It is possible to adapt the climate policy design in the model, leading to results that are better aligned with observed targets. This is for example done in an already published paper applying GCAM-Europe for the NECP targets until 2030 (Frilingou et al., 2026), hinting that the divergence observed here should not be interpreted as undermining the epistemological value or robustness of the model itself, but rather as reflecting the stylised scenario design.

Frilingou, Natasha, et al. "Cost-optimal vs. policy-driven scenarios for a decarbonised European energy system." Environmental Research Letters 21.3 (2026): 034023. https://iopscience.iop.org/article/10.1088/1748-9326/ae3f45

To reflect on the interesting discussion above, we also added a new paragraph in the main text:

"Comparing GCAM-Europe outputs with observed historical data (based on Eurostat) as well as planned targets (based on the European National Energy and Climate Plans (NECPs)) for the use of biomass, CCS, and nuclear technologies (Figure S13), we observe behaviours that closely follow real-world / planned trends for the Baseline scenario, but depart from those trends in the Policy scenario, notably from 2025 for bioenergy and CCS, and from 2030 for nuclear. To interpret this deviation, it is important to consider that despite the existence of stringent EU climate policy within the latest NECPs, their design differs significantly from the simpler universal carbon price followed in the stylised Policy scenario. As such, although achieving negative emissions through combining bioenergy and CCS is not currently subsidised (e.g., through the Emission Trading Scheme), these technologies receive significant subsidies in the Policy scenario, resulting in this increased use. This also hints that ensuring policy relevance in GCAM-Europe requires a dedicated climate policy design in the model rather than simple economy-wide targets, to ensure that outcomes remain technically and societally feasible."

* what are the carbon prices in the policy scenario?

The revised version of the manuscript includes a table (Table S2) that presents the carbon prices used in the policy scenario by period and region (2015$/tCO2):

CO2 market	GCAM region	2020	2025	2030	2035	2040	2045	2050
European Union	EU27 countries	191	308	349	374	412	478	532
EFTA+UK	Iceland; Norway; Switzerland; UK	72	284	323	376	416	483	535
Other Europe	Albania; Belarus; Bosnia and Herzegovina; Macedonia; Moldova; Serbia and Montenegro; Turkey; Ukraine	51	40	51	90	213	296	351
China	China; Taiwan	68	58	62	155	212	272	383
India	India; South Asia	2	0	0	123	187	239	301
Jap & Kor	Japan; South Korea	15	237	305	398	432	558	706
Latin America	Argentina; Brazil; Central America & Caribbean; Colombia; Mexico; South America Northern; South America Southern	25	187	191	281	313	396	416
MENA	Africa Northern; Middle East	0	75	162	217	220	269	321

Russia & Central Asia	Russia; Central Asia	0	34	62	111	205	299	393
South-East Asia	Indonesia; Southeast Asia	0	0	38	159	241	300	333
SS Africa	Africa Eastern; Africa Western; Africa Southern; South Africa	0	24	85	152	213	318	416
US & Canada & Aust	Australia_NZ; Canada; USA	131	255	311	402	448	443	439

* what are techno-economic assumptions for nuclear power, what is assumed for wind and solar? do these assumptions reflect costs observed in the recent EPR projects in France, Finland, UK?

The current version of GCAM-Europe (v-7.2.0) is calibrated to 2015 as the base year, similar to the analogous version of GCAM-core. Techno-economic assumptions for all generation technologies (including nuclear, wind, and solar) are adopted from the core GCAM version and primarily based on data from National Renewable Energy Laboratory (NREL), including capital costs, O&M costs, and future cost trajectories to ensure internal consistency within all regions of the model. These are documented in the GCAM documentation repository (https://github.com/JGCRI/gcam-doc).

These assumptions are standardised and do not explicitly reflect the higher realized costs observed in recent EPR projects and may not fully capture recent country-specific trends. While we acknowledge this limitation, we would like to highlight that GCAM-Europe is under continuous development, and an ongoing update will shift the calibration year to 2021. This update will incorporate revised techno-economic inputs that better reflect recent empirical cost trends across technologies and regions, including nuclear, wind, and solar. Importantly, the model framework is designed to be flexible, allowing users to modify techno-economic assumptions. This flexibility enables alignment with alternative data sources or harmonisation with other integrated assessment models in multi-model comparison exercises.

We have revised the Discussion section accordingly:

"As the current version of GCAM-Europe is calibrated to 2015, adopting this updated calibration will better align the model with recent techno-economic assumptions and is therefore expected to improve the robustness and reliability of future projections."

For GCAM-EU to be of epistemic value, it is important that the model is carefully parameterized and vetted for the EU context. In the current version such vetting and applicability is not convincingly demonstrated.

I would ask the authors to address the questions raised above and analyze consistency of model with current trends.

Thank you for this comment. We would like to clarify that the primary objective of this paper is to present a technical "Model Description paper", focusing on the structure, capabilities, and functioning of GCAM-Europe, rather than to deliver a fully policy-calibrated "Current Policies" scenario (e.g., Fit for 55 or NECP-aligned pathways). The latter requires an additional layer of scenario design, policy translation, and iterative validation, which we explicitly identify as a next step in ongoing work.

For that reason, we include a systematic comparison between calibrated model inputs and historical data (Table B1), which provides an initial consistency check against observed values. The discussion section has been revised to more clearly state that reproducing real-world policy packages or country-level targets requires both the careful scaling and harmonization of policy inputs and the vetting of model outputs against the latest historical data and short-term trends. We also highlight planned developments, including recalibration to a more recent base year (e.g., 2021), which will improve alignment with current trends and reduce structural lag in key variables. In addition, we outline a structured validation and vetting strategy based on emerging assessment protocols (e.g., pIAMvalidation), and have added relevant references (e.g., Rodrigues et al., 2026) to clarify this approach:

"*Finally, while the implementation of a stylised policy in GCAM-Europe is useful for illustrating the model's functionalities, it may generate behavioural responses that are not fully realistic across all variables and countries considered. Incorporating real-world European policy frameworks, such as the Fit for 55 package and the National Energy and Climate Plans (NECPs) (Rodrigues et al 2026), would require additional validation of model outputs against the most recent historical data and short-term trends. This validation process is planned for near-term integration and will follow established protocols for model validation (Weigmann et al., 2025) and feasibility assessment (Brutschin et al., 2021). In this line, 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.*"

Furthermore, following the editor's recommendation, the revised manuscript incorporates a more detailed analysis of the model's consistency with recent trends for selected variables, such as bioenergy and CCS, as described in our response to Comment #1.

Overall, while we understand that a policy scenario validation exercise is beyond the scope of this model description paper, we have clarified the model's current level of empirical grounding and provided a concrete roadmap for comprehensive vetting in subsequent work.

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