Core Model Proposal #425: GCAM Bugfix - Spring 2026

Product: Global Change Analysis Model (GCAM)

Institution: Joint Global Change Research Institute (JGCRI)

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Related sector: gcamdata

Type of development: bugfix

Purpose: This core model proposal contains various bugfixes and other minor improvements collected from December 2025 – May 2026.

Description of Changes

Removed SRES HDD/CDD

Previously, GCAM included HDD & CDD input files based on CMIP3 results, which are very outdated. This CMP removes those input files and the processing that generates them. Specifically, we have:

- Removed data from the `inst/extdata/energy/GIS;`
- Modified the processing in `zenergy_L143.HDDCDD.R` to only process the constant HDD/CDD files;
- Changed the variable name in `zenergy_L144.building_det_en.R` and `zenergy_L244.building_det.R` to "SCEN" instead of "SRES" since SRES has been removed. Note: we did not add new scenarios, but have retained the processing to facilitate their inclusion later;
- Modified the processing in `zenergy_xml_HDDCDD.R` to remove input files based on SRES;
- Removed chunks that produced xml files for GCAM-USA.

Fix driver error

There were a number of warnings generated when running gcamdata. These get missed during development of individual core model proposals for a veriety of reasons:

- `driver()` performs more checks than `driver_drake()` on ensuring precursor and other meta data are properly set. However most users have understandably switched to `driver_drake()` for development.
- Missed in the bevy of warnings related to BYU related suggestions to update various data sets.
- Infrequently run gcamdata unit tests

These fixes tend to be straightforward and amount to adding the missing data, or avoid the “forbidden” functions which are flagged.

Fixes related to timeshift and running a hindcast

The vast majority of changes in this CMP are related to the timeshift test. The timeshift test sets the final historical year to 1990 and moves all model years from 2005 onward to "future" years. The largest change was to add a new constant to represent the final historical year (FINAL_HISTORICAL_YEAR), as in the core `MODEL_FINAL_BASE_YEAR` was sometimes used to signal the final historical year and sometimes used to signal the final base year. The timeshift test updates `MODEL_FINAL_BASE_YEAR` to 1990, but leaves the `FINAL_HISTORICAL_YEAR` as 2021. For almost all other changes, we make them conditional on being in timeshift (i.e., in an if `UNDER_TIMESHIFT` block). Changes include:

- Modifying `set_years` to use an updated `YEAR_RECODE` when `UNDER_TIMESHIFT` is true
- Change approach to replacing invalid emissions coefficients under hindcast (see `module_emissions_L201.en_nonco2.R`). The core model replaces `Inf` with 1 for some emissions coefficients. The `Inf` is generated when there is no production data for a technology. In the core model, these coefficients are overwritten with realistic values in the subsequent calibration years. However, under a hindcast, they may not be. For now, coefficients have been set to zero for technologies with zero production. However, at some point, we may want use values estimated from other years / technologies.
- Adjusting the processing of retirement inputs to ensure the data is available for the correct years (see `zenergy_L223.electricity.R`)
- Removed shareweight interpolation rules for industrial subsectors where the supply is zero in the final calibration year, but the future years have a positive coefficient (see `zenergy_L232.other_industry.R` and `zenergy_L2327.paper.R`). This only impacts other industrial feedstocks and process heat paper in a small number of regions, but without it we get solver fails as the model requires demand for it but supply is not possible.
- Ensure subsector share weights exist in all base years (see `zenergy_L2392.gas_trade.R`)
- Specify base years under hindcast for data sets that may not include all historical years (see `zenergy_L2323.iron_steel.R` and `zgcamusa_L171.nonghg_trn.R`)
- Removing NAs or replacing NAs and Infs with zero in special cases (flagged in if `UNDER_TIMESHIFT` blocks). Note: in each case, it was confirmed that the change was needed, the updated inputs made sense, and the files worked correctly.

~50 chunks were changed and the test passed with v8.6; however, subsequent changes to the core model included in v9.0 will require more updates to ensure timeshift passes again.

Other test-related updates

In addition to fixes that enable the timeshift test to pass, this CMP includes several other test-related updates:

- Renaming constants so that `test_globals` passes
- Remove forbidden function calls from `module_energy_L1321.cement`
- Added test for hardcoded years (Note that it currently fails, but is included so we can see where future fixes are needed). Test also includes a helper function called `screen_years` in `utils.R` .

Fix Buildings "other" naming collision

In GCAM v8.8, for the USA region only, we expanded the detail of the buildings sector to be more consistent with the representation in GCAM-USA given the data we already had. A last minute decision to "harmonize" names of resid / comm "other" to "others" to be consistent with the name used for the rest of the GCAM regions ended up having an un-intended consequence. It created a naming collision in the global technology database and inadvertently included technologies not intended for the non-USA regions. The H2 technology in particular

which was meant to only provide service in niche use cases not the VERY general category "others" represents in non-USA regions.

With the reversion of this 8.8 change, the GCAM-USA naming is returned to the prior model versions (i.e., there are both "other" and "others" services, where "other" is electricity, gas, and liquids, whereas "others" is biomass and coal), and the USA region of the default configuration also has this naming. Fundamentally, the reason for the differentiation is that "other" services in the USA are a comparatively narrow set of services, whose non-energy costs are set high in order to reflect that fuel generally accounts for a small portion of the total service price. For example we wouldn't expect electricity price increases to reduce the use of MRI machines, elevators, or coffee machines. In the non-US regions, and for the "coal" and "biomass" fuels within the USA, the "others" services have a broad definition and are assigned comparatively low non-energy costs, consistent with heating technologies in general.

Fix Forest Warnings For no CalOutput but Land read in Messages

Forest are in different units than other Ag commodities and given we are using the same number of digits to round on the land side for all, using aglu.DIGITS_CALOUTPUT for Forest output makes it more likely they will generate zero production / positive land warnings. Thus we allow more digits for Forest consistent with the difference in unit scales.

Alumina and Aluminum

The units provided in the A326.globaltech_cost.csv assumption file (as well as noted in the original CMP) are in terms of 1975$/GJ. However these non-energy cost assumptions are passed directly to XML within the “alumina” and “aluminum” sectors which are expecting price units of 1975$/kg.

Checking alumina and aluminum prices generated by GCAM using these assumptions yield prices which are roughly and order of magnitude larger than real world observed prices.

This matters for a couple of reasons:

- The sector is un-responsive to high fuel or carbon storage costs.
- It greatly inflates the calculated capital investment demands for the sector.

Here we implement a temporary fix to ensure aluminum non-energy costs are in the appropriate range. A more focused effort is needed to ensure details such as relative cost differences for cogen and CCS technologies; The capital ratio makes sense (we are not currently capturing feedstock costs); And why there is so much variability in IO coefficients for both fuel and Alumina into Aluminum.

Additionally, IO coefficients for alumina CCS technologies in the global technology database were zero due to a rounding issue in gcamdata; this has been corrected. An additional fix was required to avoid CCS technologies being more efficient than technologies without CCS for the same region and fuel. This was addressed by calculating the ratio between non-CCS and CCS

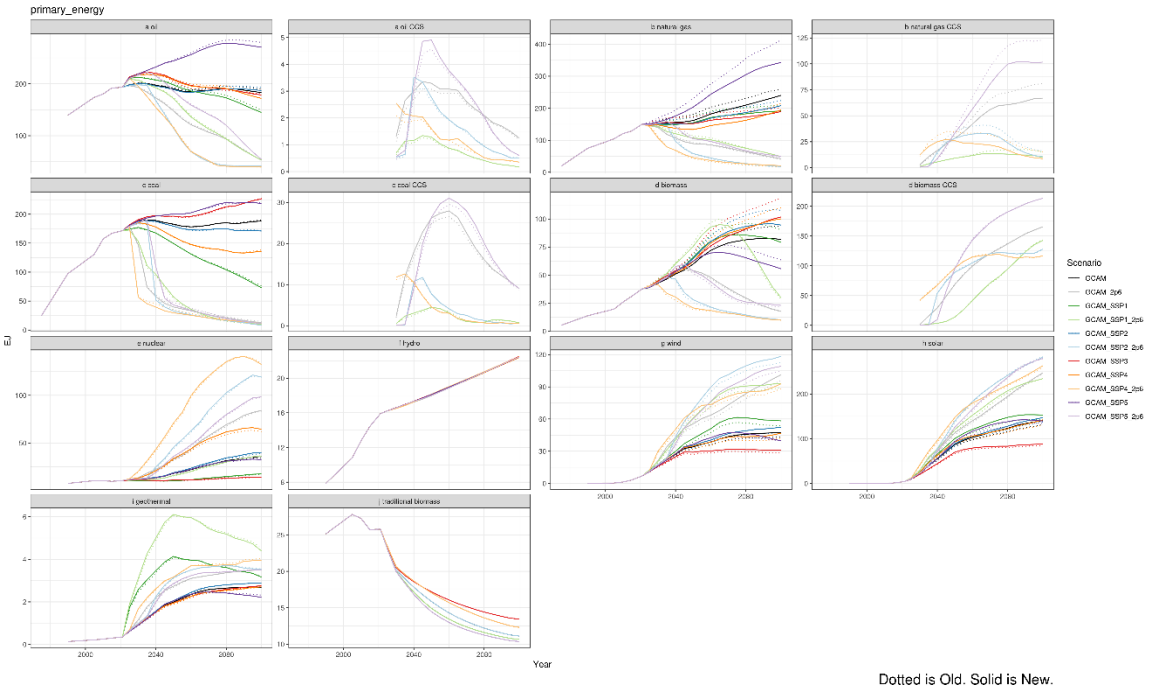
alumina technologies of the same fuel from the global technology database and applying those ratios to regional non-CCS IO coefficients in order to derive regional CCS IO coefficients which are consistent with their non-CCS counterparts.

Other fixes

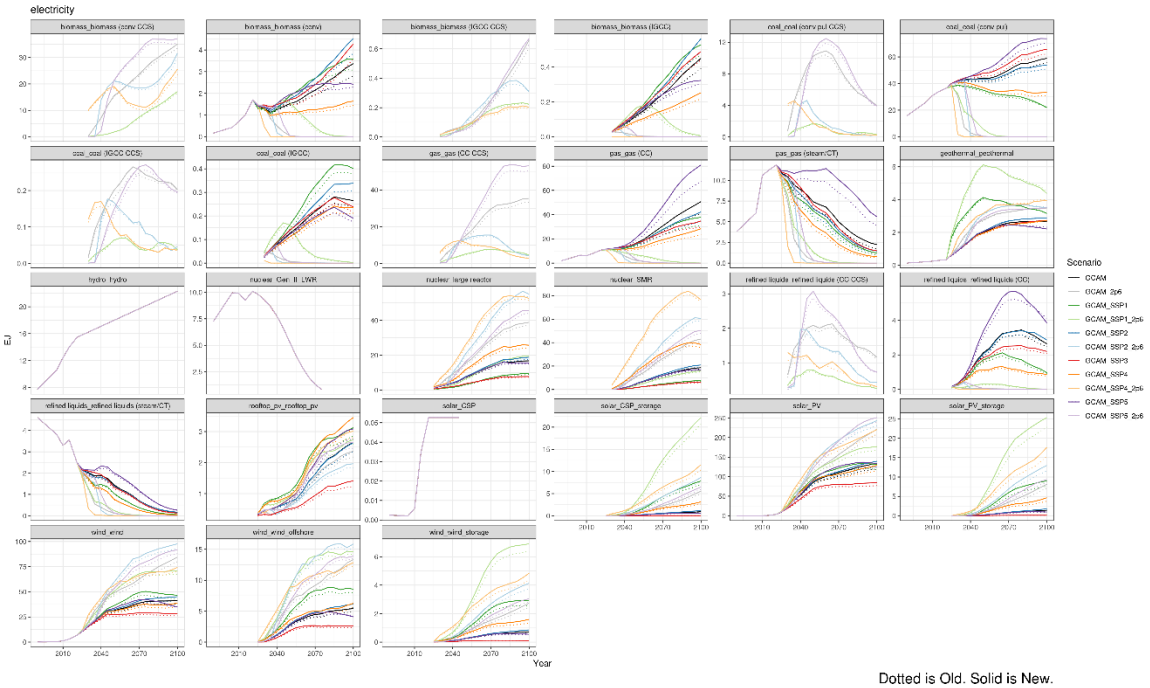
- Fix error in linear-control object that could result in random large values in rare instances. See `cvs/objects/emissions/source/linear_control.cpp`
- Write out market name for "minicam-energy-input" to the debug file. See `cvs/objects/functions/source/energy_input.cpp`
- Fix units for detailed Capital Investment by tech query results. The units were noted simply as “1975$”, however they should be “billion 1975$ per timestep”.
- Bugfix when running XMLDBDriver.jar via command line where we did not correctly do "unit conversions" for the buffer size argument (given in MB) in all of the places it was needed.
- Drop en_transformation_low.xml from SSP3 batch files as it was removed in gcam-v8.8. **Note** a better solution may be warranted here.
- Fix message printed with each GCAM run directing users to find GCAM at http://www.globalchange.umd.edu/models/gcam; which should now be https://github.com/JGCRI/gcam-core. **Note** this text is also included at the top of every GCAM source file and needs to be updated there as well. However, we prefer to do that as a stand alone PR for ease of review.

Validation

Apart from the "comm other" building bug fix results should be mostly the same as the current Core. However that bug does have a very substantial impact on energy results. Impacts would of course be more limited for Ag / Land Use results.



Dotted is Old. Solid is New.



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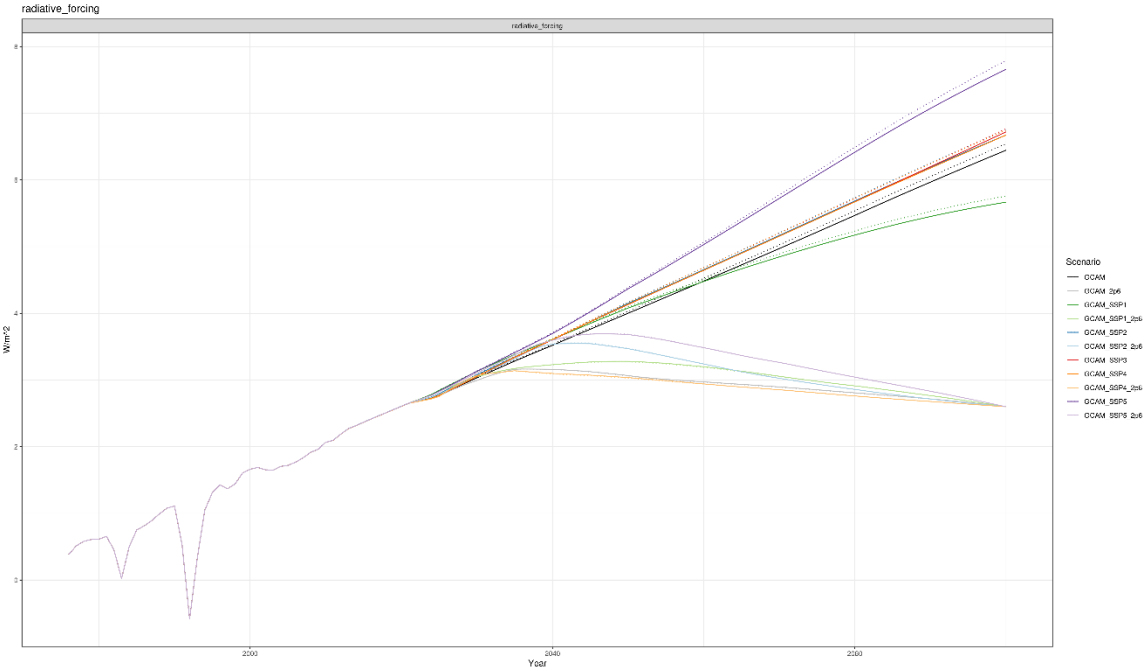
radiative_forcing



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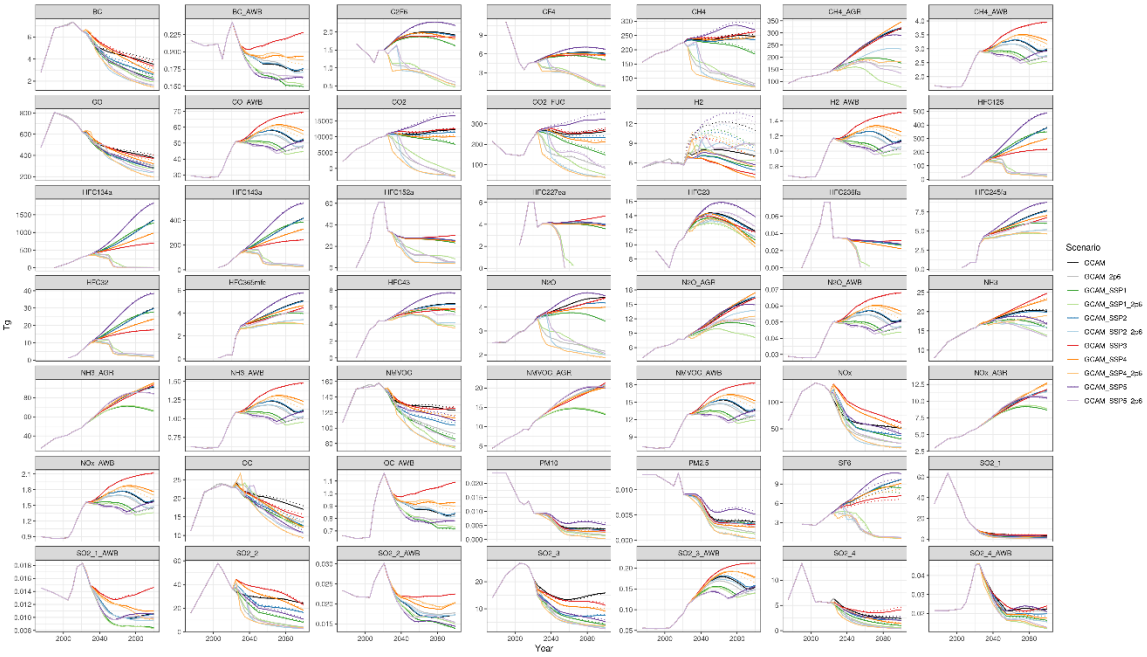
nonCO2_emissions



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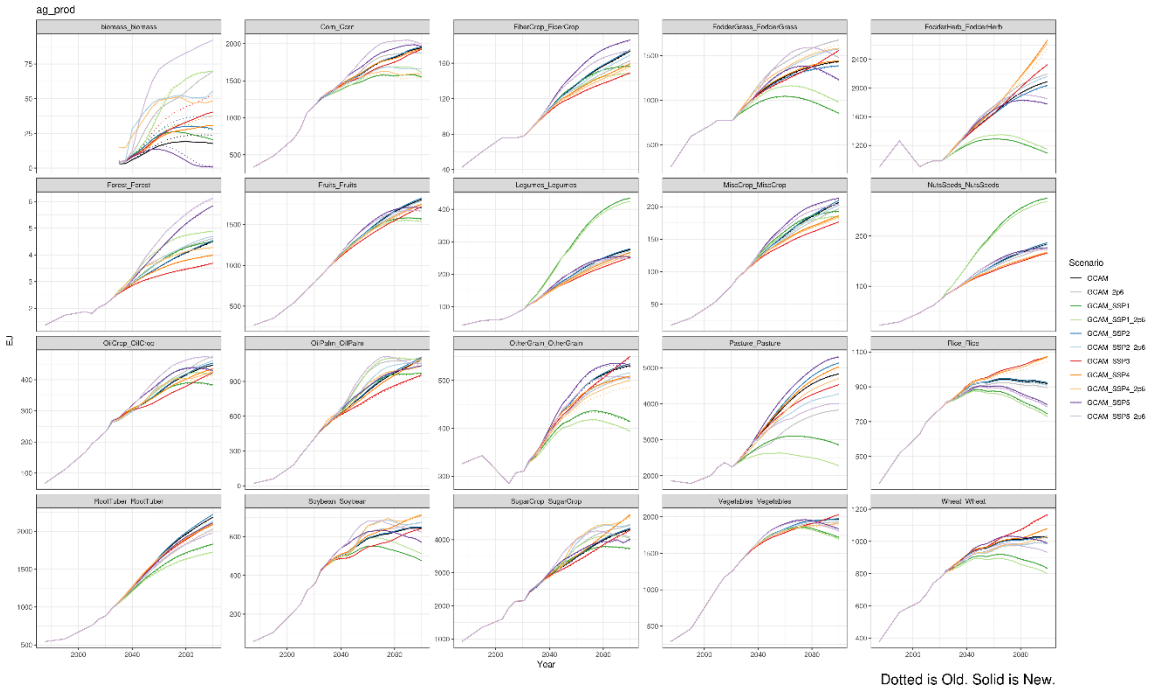

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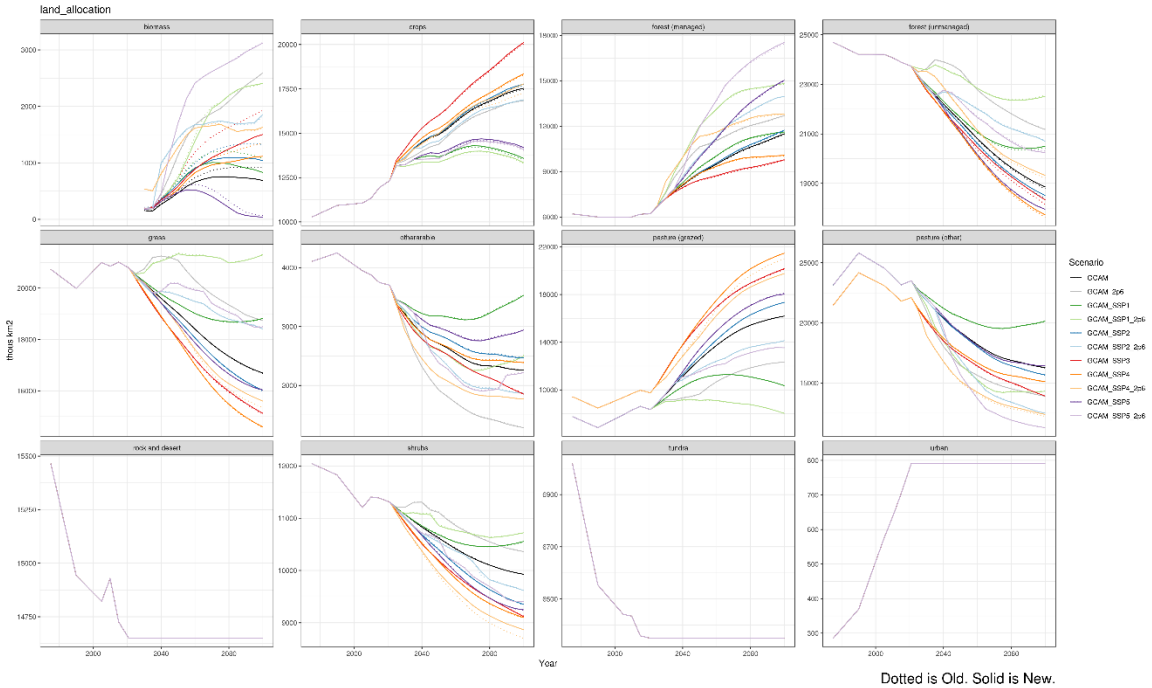

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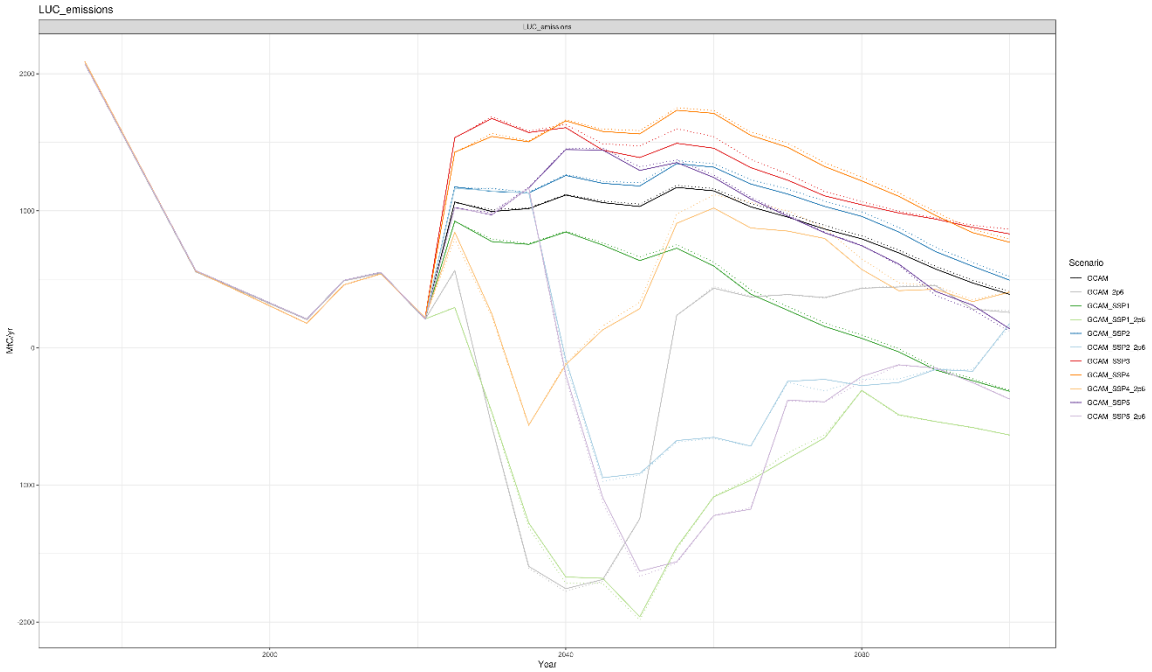

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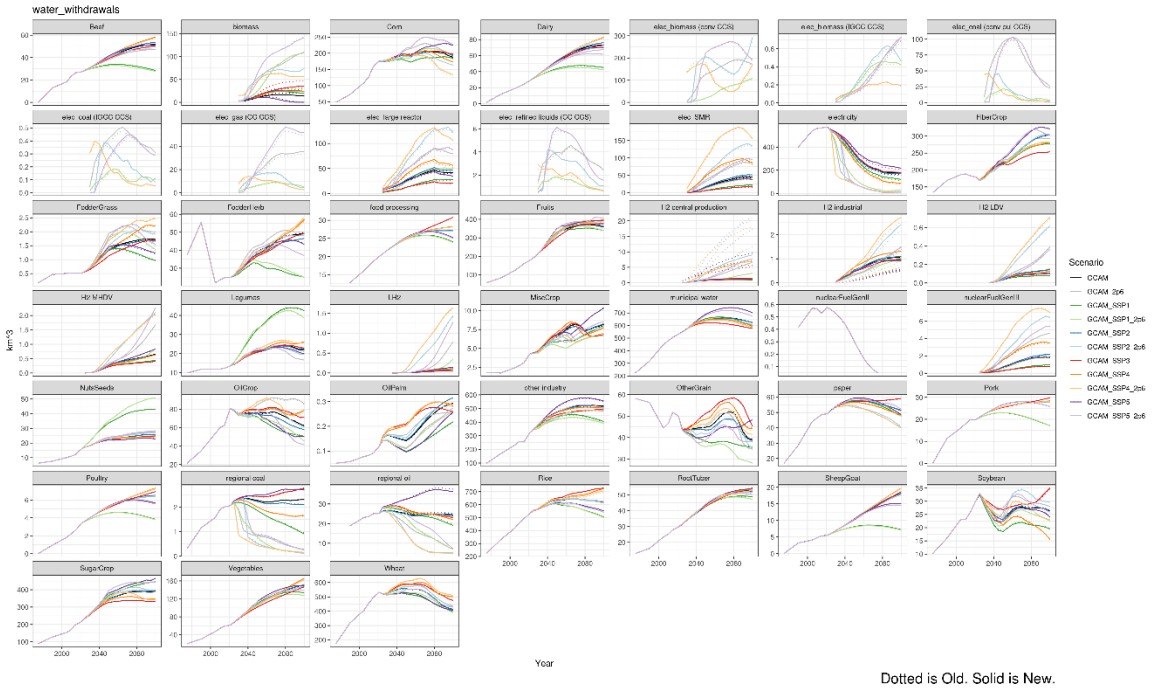
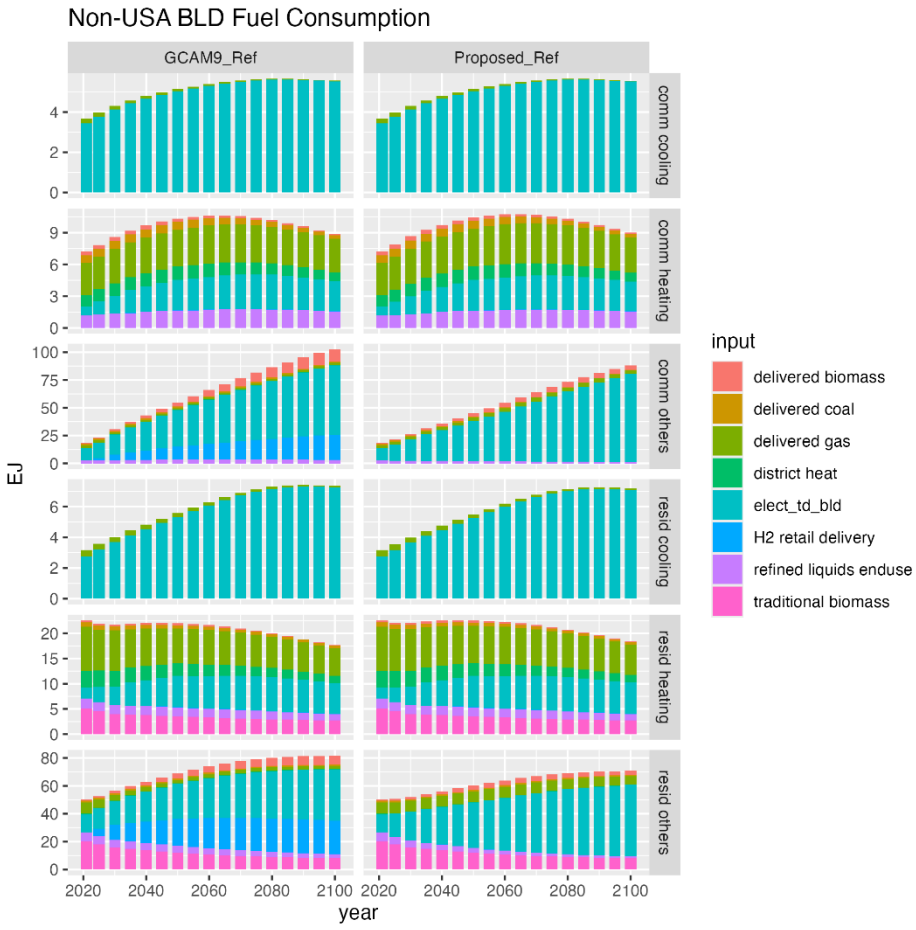


Dotted is Old. Solid is New.

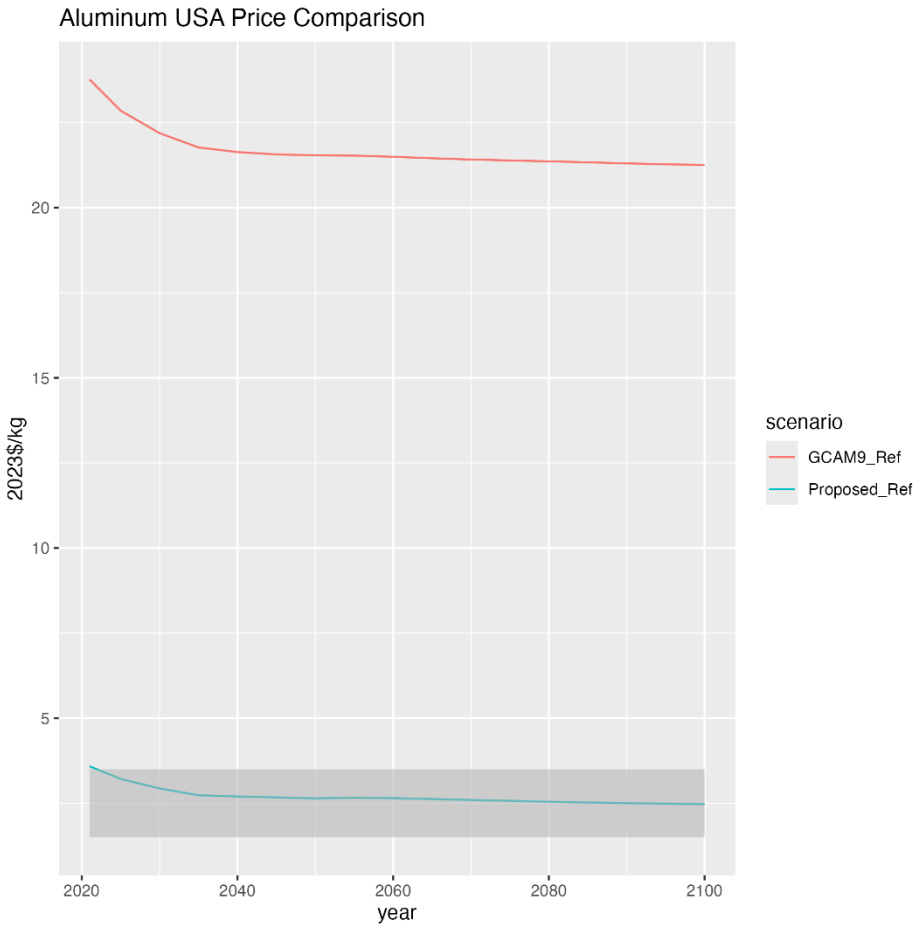
Non-USA Buildings Energy Use

Taking a look directly at buildings energy usage we can see that the "others" category is the one which is significantly different, in H2 demand in particular.

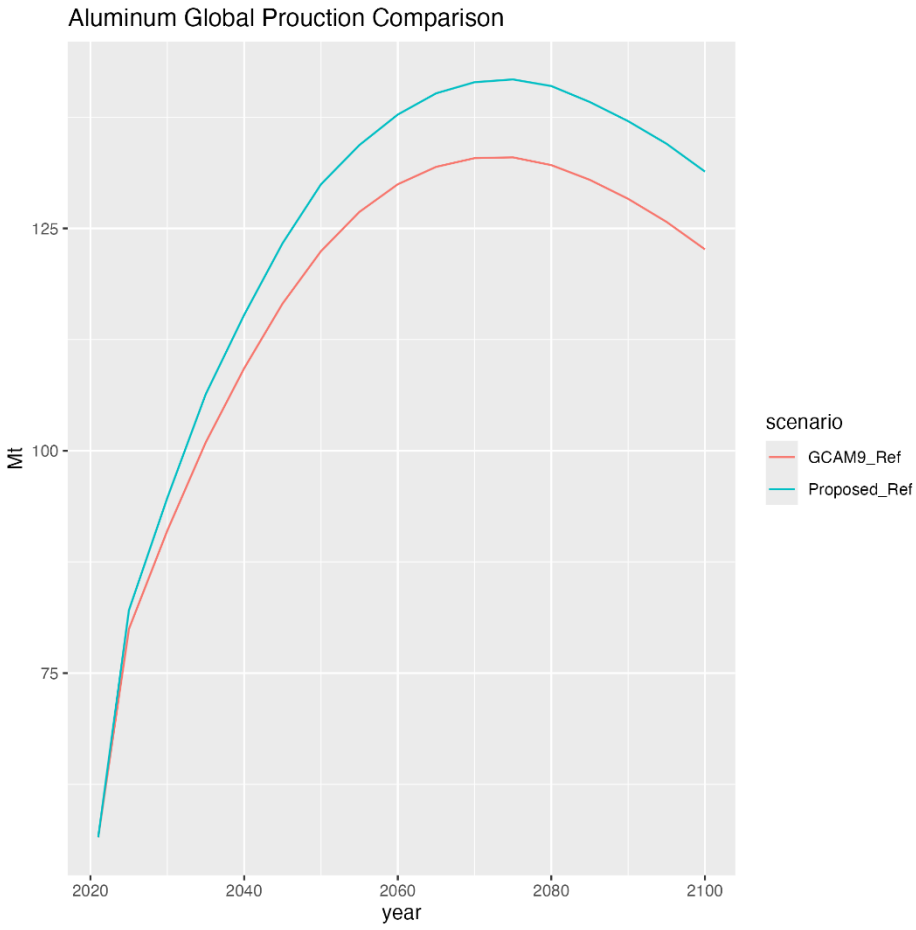


Aluminum Results

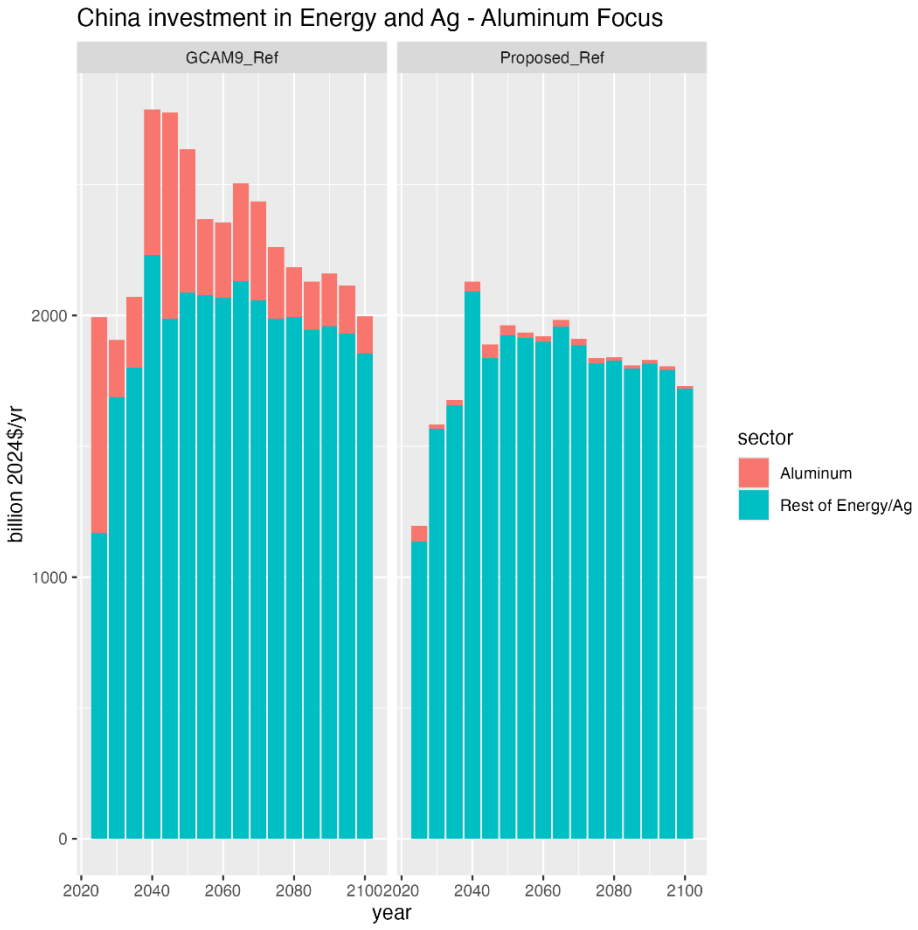
We can verify a more reasonable Aluminum sector price is generated with the updated non-energy costs (note the shaded area denotes the range of recent real world USA prices for Aluminum).



Given non-energy costs are held constant while energy efficiency is assumed to have tech change we do see price elasticity generate a bit more growth in Aluminum demand in the proposed results.



The updated non-energy costs also produce more reasonable levels of investment in the Aluminum sector, particularly noticable in China.


China investment in Energy and Ag - Aluminum Focus
GCAM9_Ref
Proposed_Ref
billion 2024$/yr
2000
1000
0
2020
2040
2060
2080
2100
year
sector
Aluminum
Rest of Energy/Ag