Considering the Timing of Updating Social Accounting Matrices and Energy Data in CGE Models for Quantifying Mitigation Scenarios

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AIM ASIA-PACIFIC INTEGRATED MODEL

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Background

Mitigation scenario studies

- Mitigation scenario studies have contributed to climate policy formulation by quantifying mitigation measures and their impacts in achieving long-term temperature targets.

Computable General Equilibrium (CGE) model

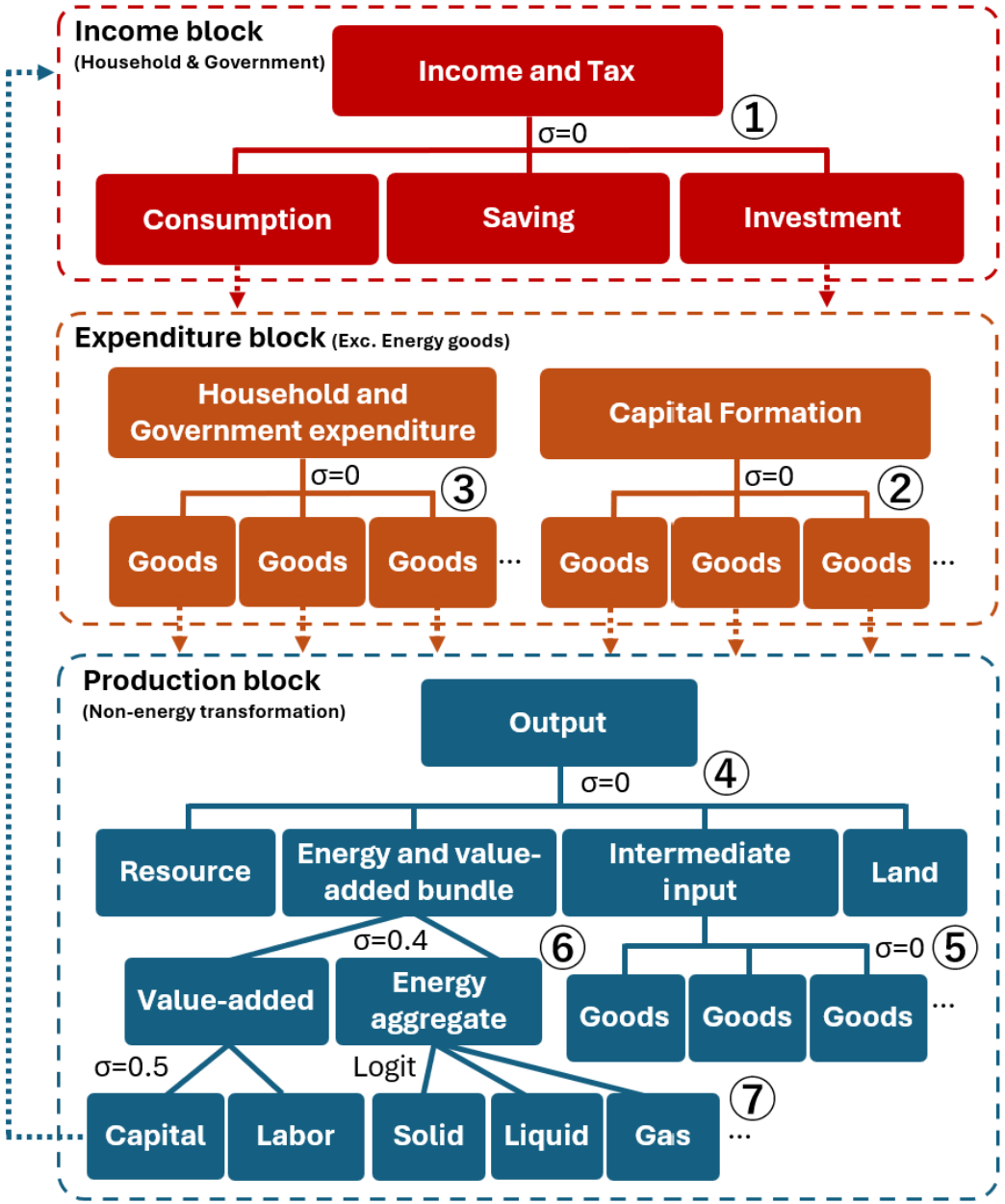
- Dynamic CGE models can quantify mitigation scenarios with detailed representations of sectors and goods, enabling analysis of the economic implications of mitigation policies.
- Many CGE models are calibrated using the GTAP and the IEA energy balance table.
- It is ideal for CGE models to be calibrated to the most recent year. However, model development resources and other factors limit the frequency of updates of calibration year.

Purpose of this study

- To provide useful information when considering the update timing of model calibration for CGE models that quantify long-term mitigation scenarios.
- To this end, we estimate multiple mitigation scenarios that achieve the 1.5C target, with varying calibration periods for energy and economic parameters.

Methodology: AIM-Hub model

- This study analyzes the changes in 1.5C scenarios when different calibration periods are set for the parameters in AIM-Hub.
- AIM-Hub is a recursive dynamic CGE model. the production and consumption of goods are represented using multiple functions.
- The model reproduces historical statistics by adjusting the parameters of the functions (6-7) that represent energy demand and supply.
- This study reproduces historical statistics from the GTAP12 database by newly adjusting the parameters of the functions (1-5) that represent the production and consumption of goods.

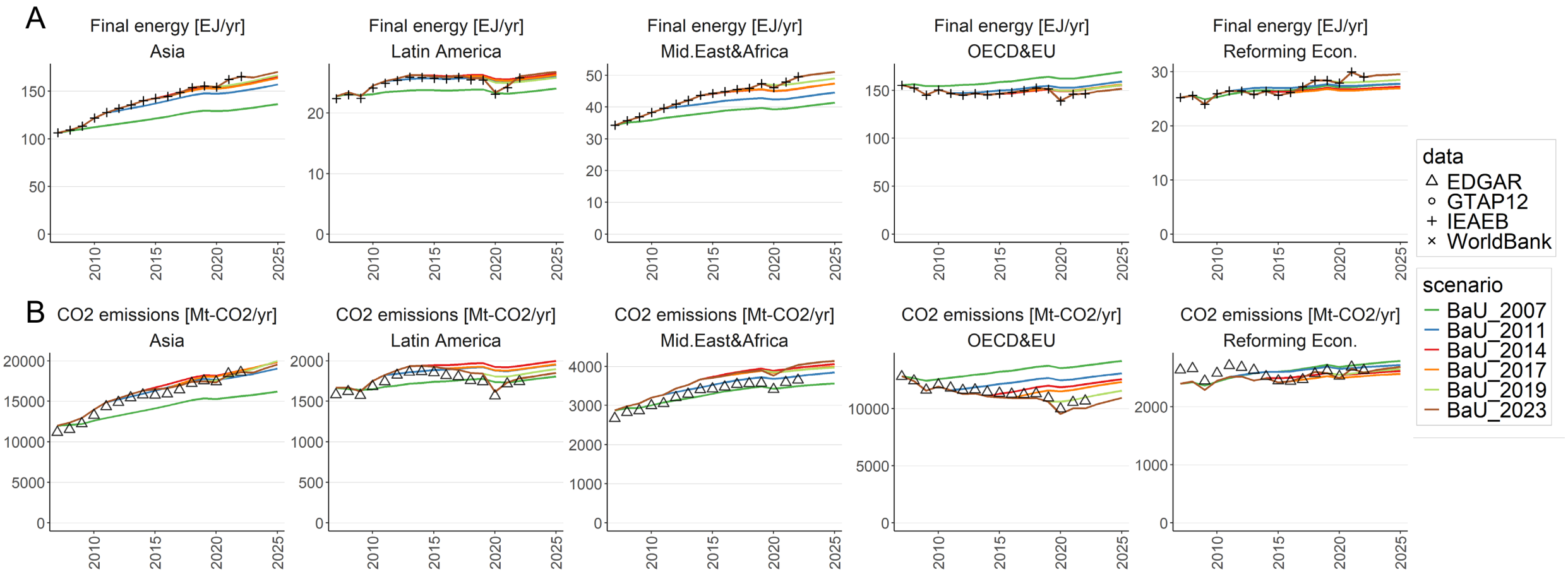


Methodology: Scenario

- This study analyzes the impact of changing calibration periods .
- Scenarios are created by combining the calibration period with or without emission constraints based on 1.5C target.
- A scenario (Miti_23IEA) is also created to analyze the situation when only energy related parameters were calibrated by 2023.
- In all scenarios, socioeconomic assumptions such as population and GDP are based on SSP2.

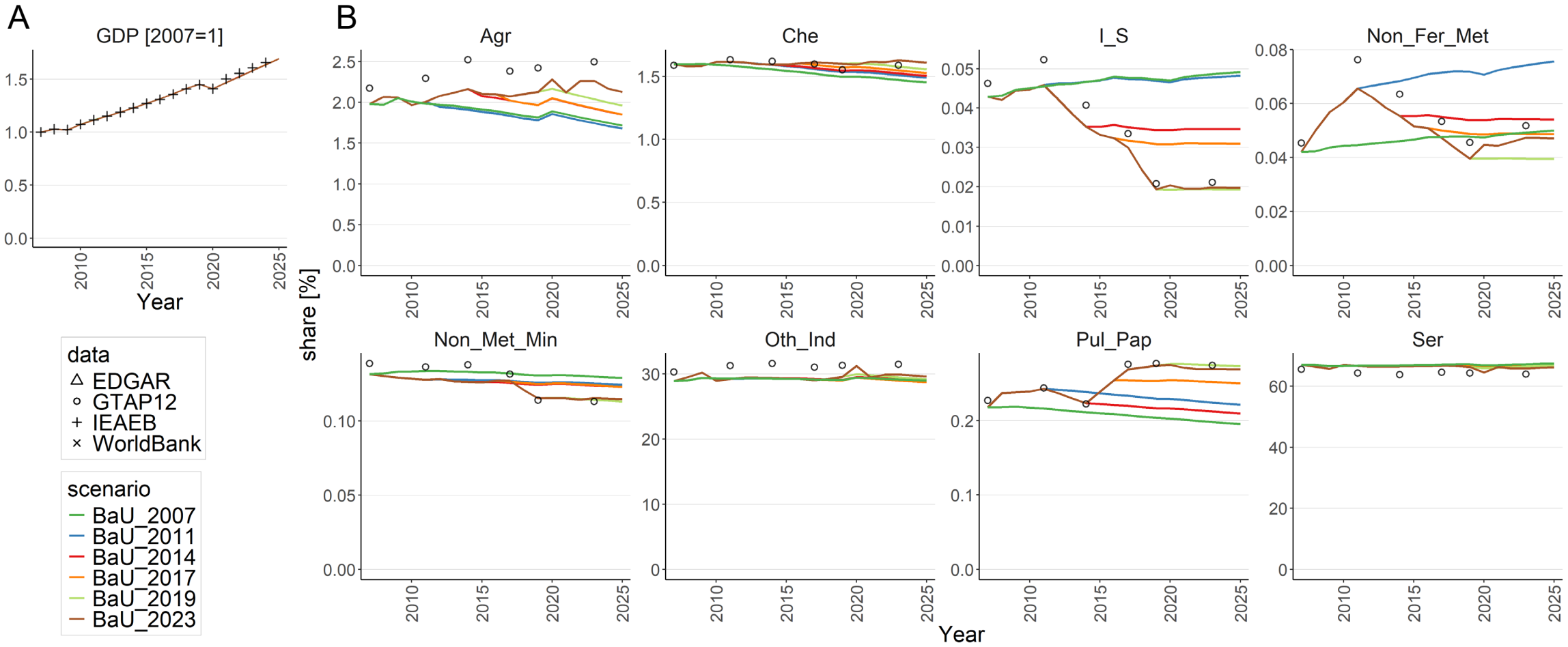
Scenario name	Calibration period	Emissions constraint (2025-2100 cumulative)
BaU_2007	2007	-
BaU_2011	2007 - 2011	-
BaU_2014	2007 - 2014	-
BaU_2017	2007 - 2017	-
BaU_2019	2007 - 2019	-
BaU_2023	2007 - 2023	-
Miti_2007	2007	400Gt-CO_2 (1.5C)
Miti_2011	2007 - 2011	400Gt-CO_2 (1.5C)
Miti_2014	2007 - 2014	400Gt-CO_2 (1.5C)
Miti_2017	2007 - 2017	400Gt-CO_2 (1.5C)
Miti_2019	2007 - 2019	400Gt-CO_2 (1.5C)
Miti_2023	2007 - 2023	400Gt-CO_2 (1.5C)
Miti_23IEA	- 2023 (for energy) - 2007 (for economy)	400Gt-CO_2 (1.5C)

Result: Calibration check



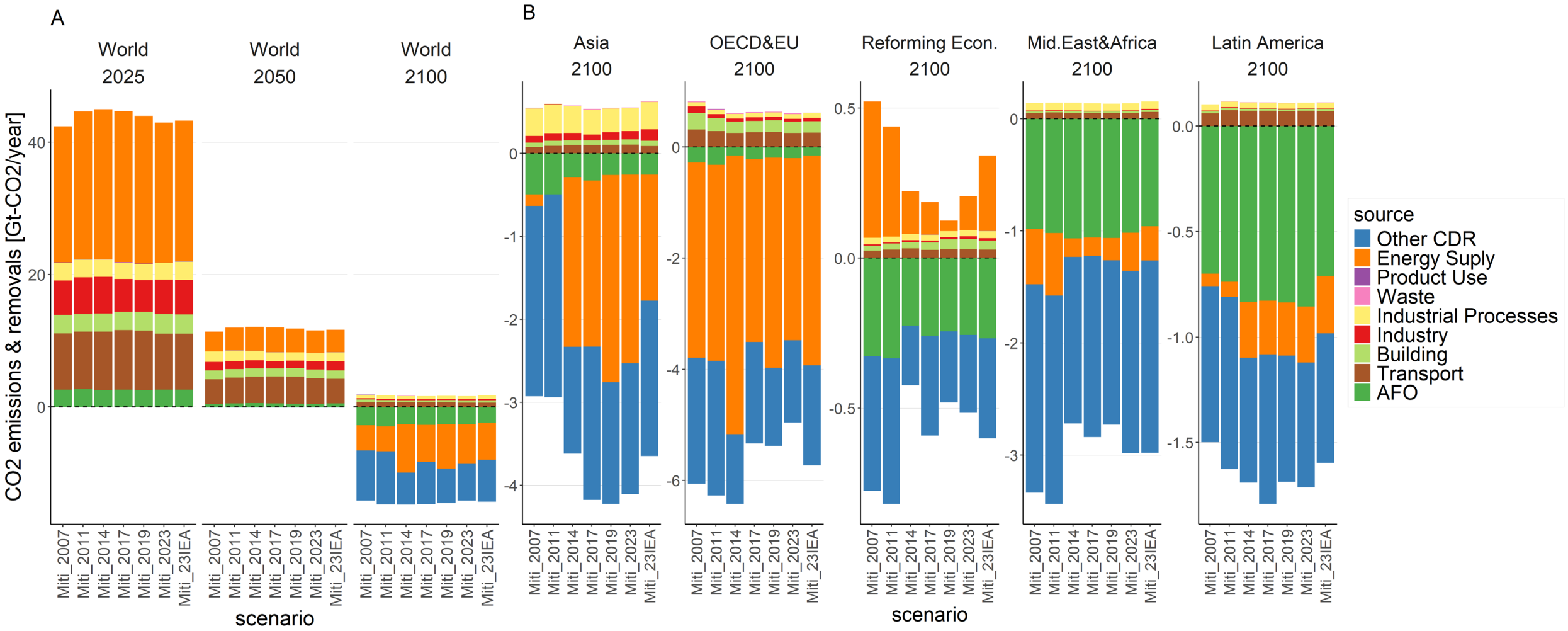
- Final energy consumption closely aligned with historical statistics.
- Although no adjustments were made for CO2 emission factors, the results were generally consistent with historical statistics.
- The effects of recent progress in reducing CO2 emissions have been observed in several regions.

Result: Calibration check



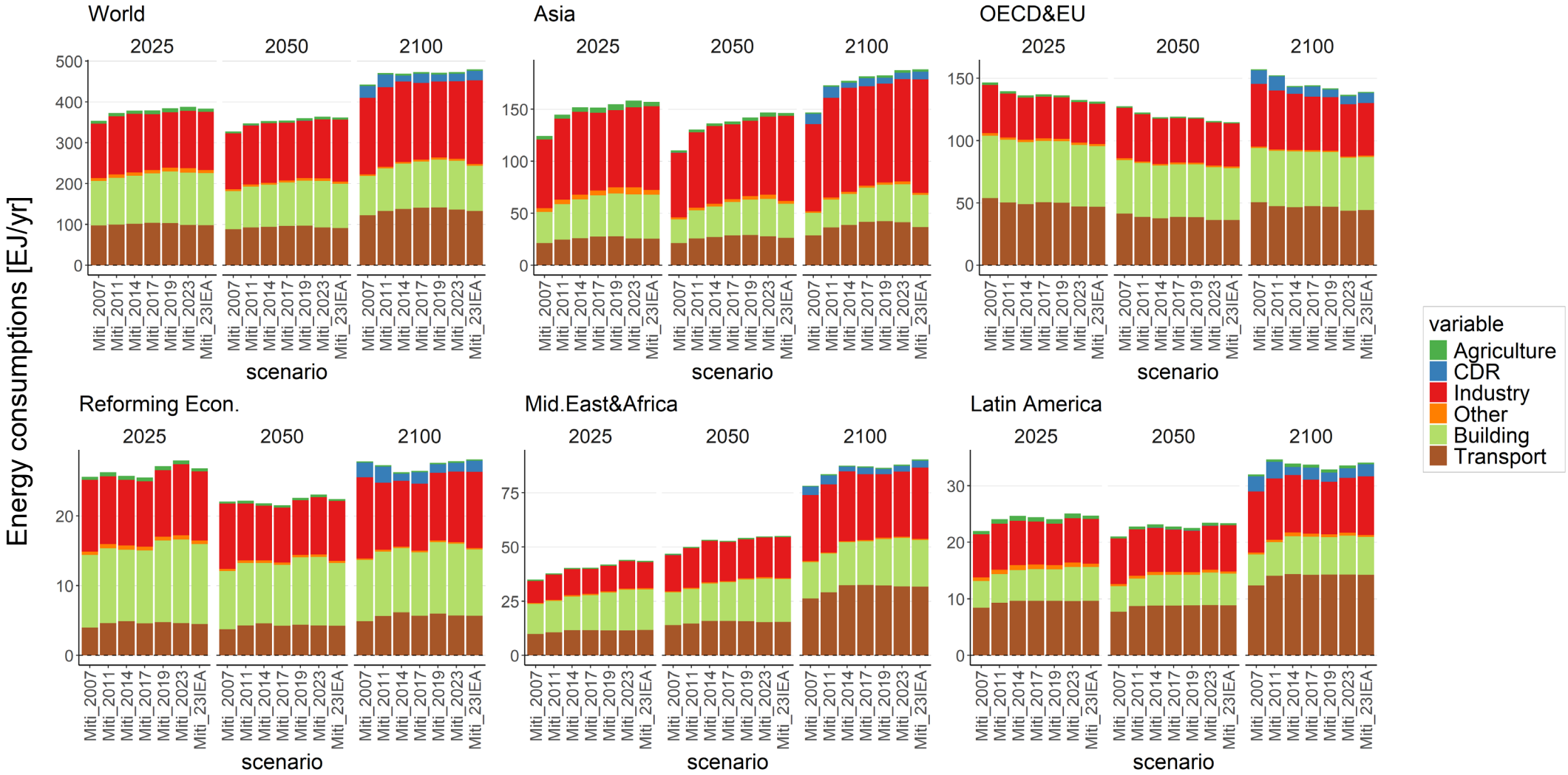
- Since GDP is based on SSP2, it showed the same value in all scenarios.
- The share of final consumption of goods (household and government consumption, capital formation) reflected past trends, although not perfectly.

Result: CO_2 Emissions/Removals



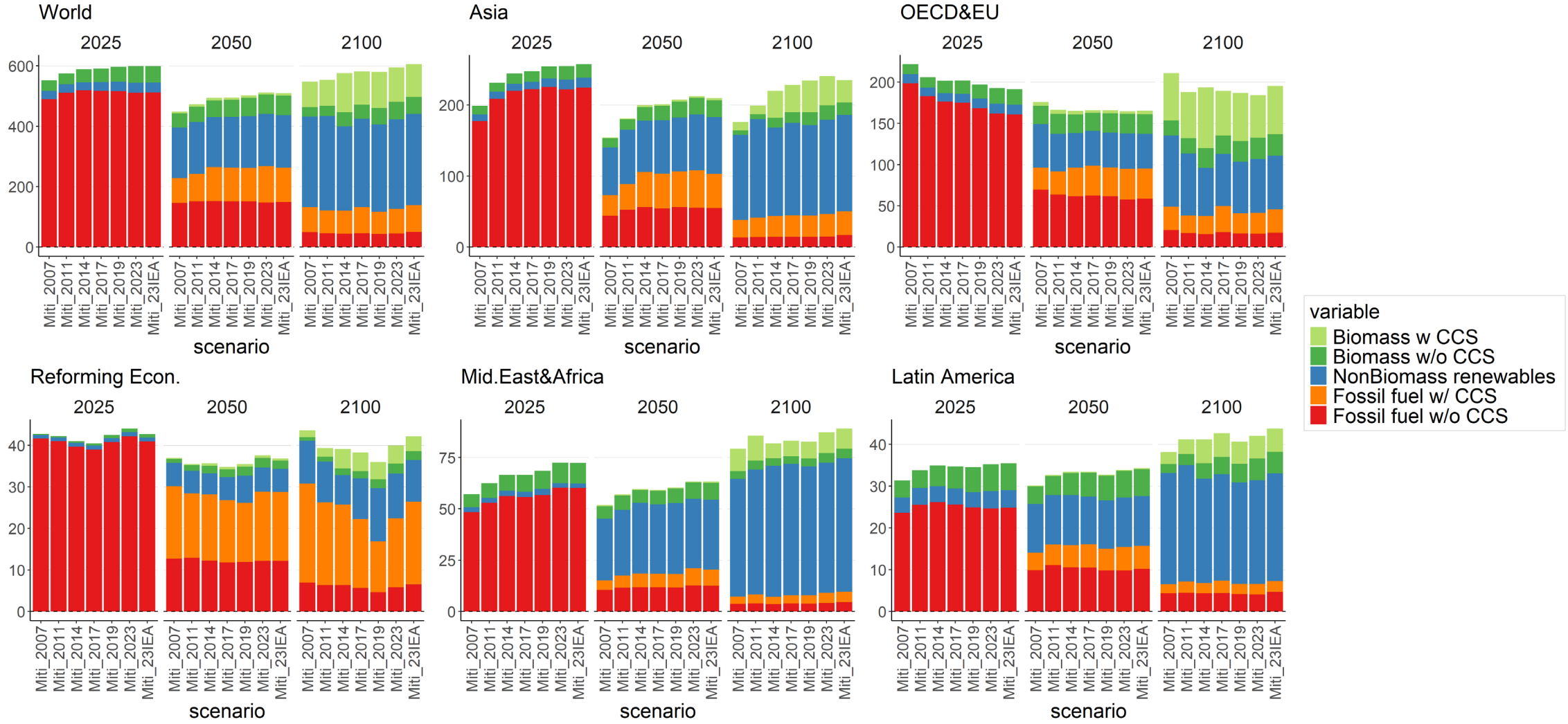
- CO2 emissions from the energy demand side are similar across the scenarios.
- The main differences across the scenarios lie in CO2 emissions/removals from the energy supply sector (including BECCS), Other CDR (including DACCS), and AFO (including afforestation).

Result: Final Energy Consumptions



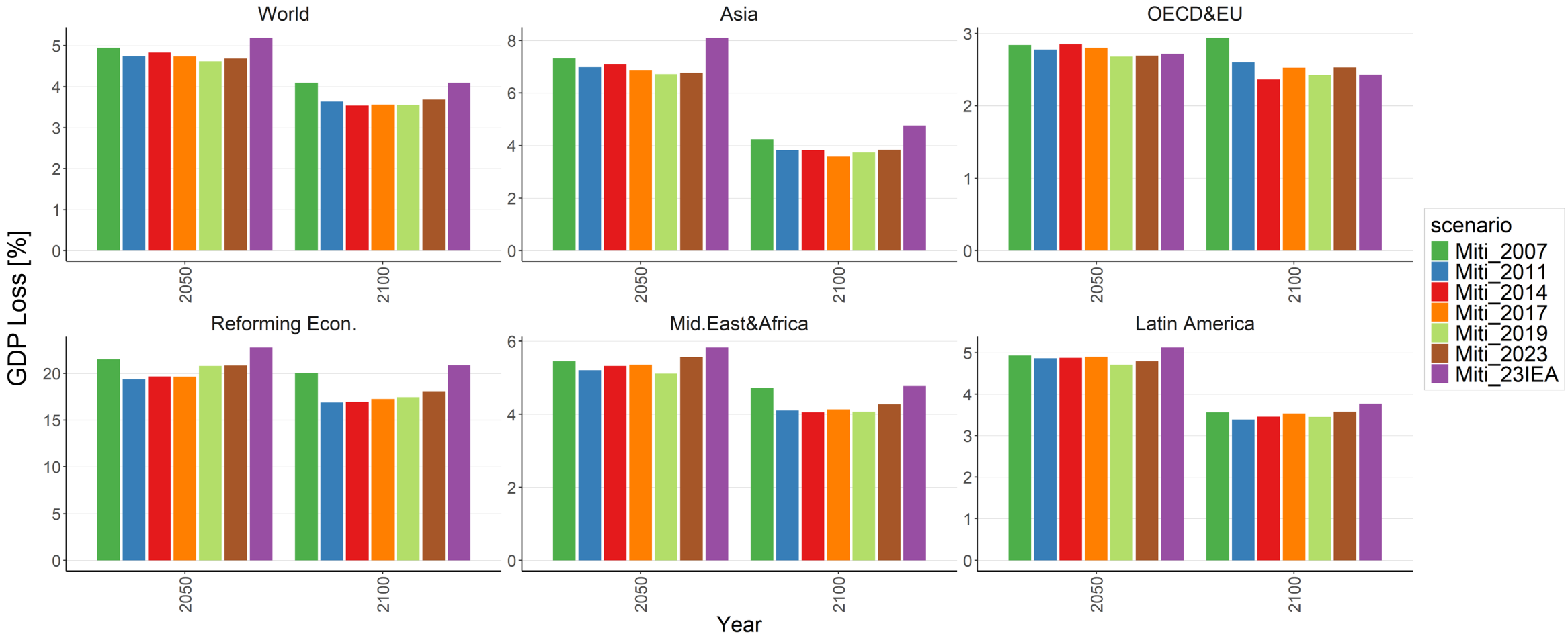
- In Asia, the difference in total energy consumption is up to 27.4% (Miti_2007 vs Miti_2023).
- In some regions, even when the same period-related energy variables are calibrated (Miti_2023 vs Miti_23IEA), differences in energy consumption in 2100 can be seen.

Result: Energy Supply



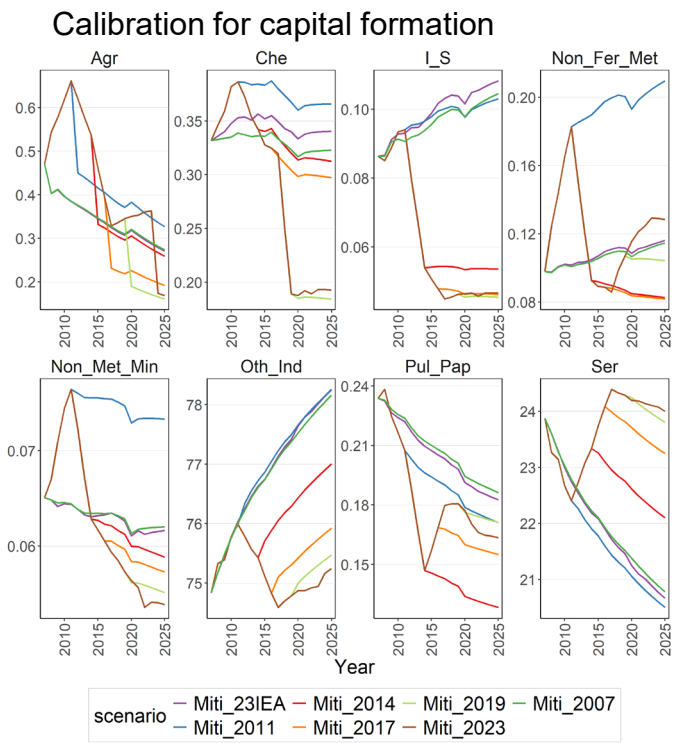
- In the Reforming Economy region, the main difference is in fossil fuels with CCS.
- In other four regions, the difference in energy demand is mainly met by renewable energy.

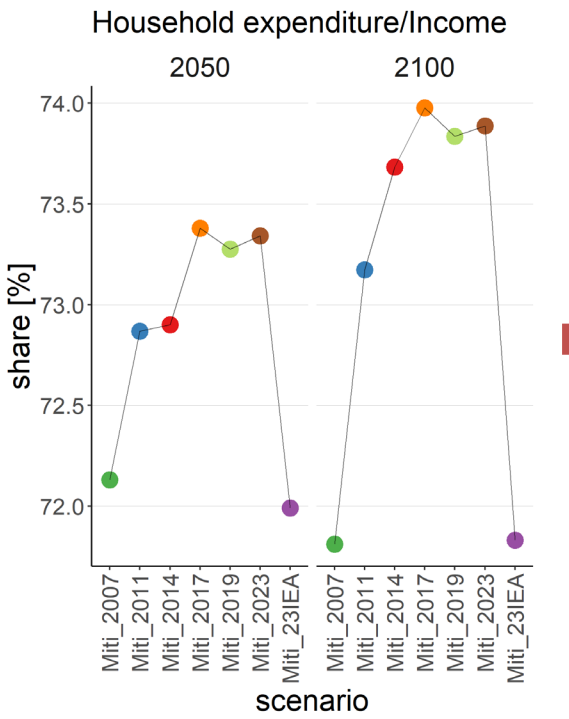
Result: GDP loss

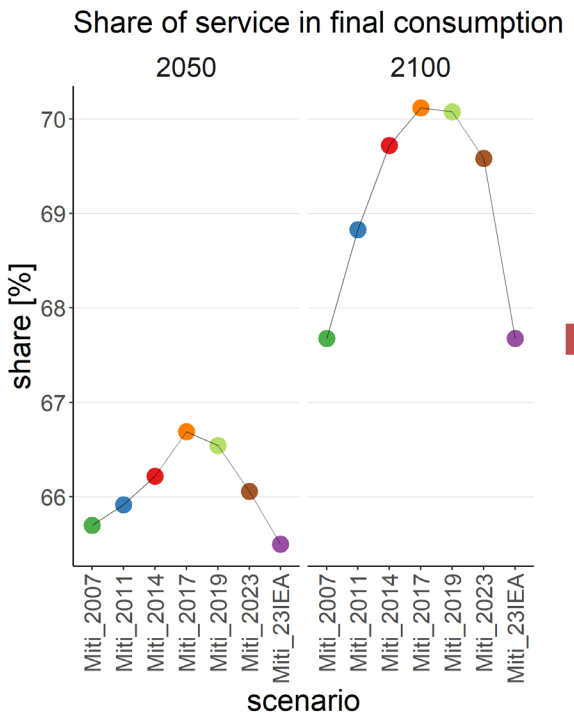


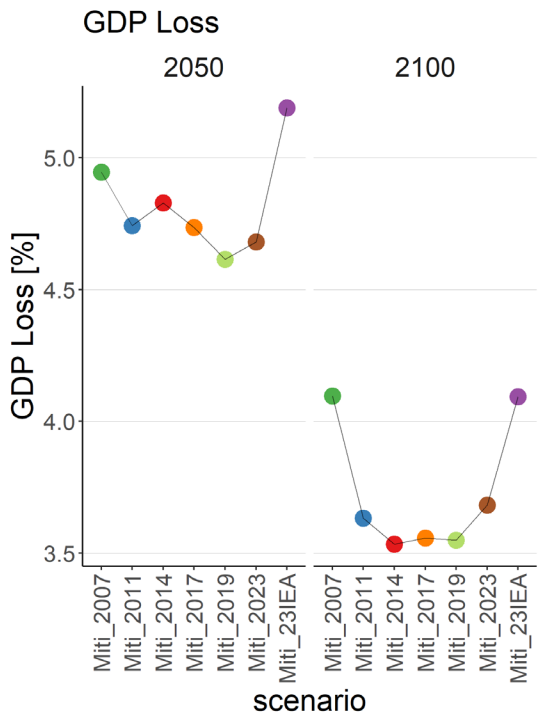
- The global GDP loss is from 3.5 to 4.1% in 2100. In most regions.
- The largest GDP losses occur under the Miti_23IEA scenario, followed by the Miti_2007 scenario.
- Large GDP losses are calculated for Reforming Economy regions that heavily rely on CCS.

Factors contributing to differences in GDP loss









- Scenarios calibrating parameters over longer periods reduced the proportion of construction in capital formation and avoided the increase in the cost of capital formation associated with future price increases (primarily energy goods).
- The reduction in capital formation costs increases household consumption and also increased the proportion of services in final consumption.
- The higher the proportion of the services sector in final consumption, the less the GDP loss is reduced. Changes in energy demand also influence the magnitude of the GDP loss to some extent.

Conclusion

- This study estimates multiple mitigation scenarios to achieve the 1.5° C target with different calibration periods for energy and economic data to provide useful information for considering the timing of updates to SAM and energy data.

- Changes in the model's calibration period did not significantly affect CO2 emissions in the energy demand sector but did affect CO2 removal by BECCS, DACCS, and EW.
- The difference in global GDP losses due to differences in model calibration periods was up to 0.6% compared to total GDP.
- Calibrating only energy parameters estimated larger economic losses in many regions compared to calibrating both economic and energy parameters.
- Changes in parameters related to capital formation would have influenced the magnitude of GDP losses through changes in the future ratio of household consumption to income.

- ➢ In studies focusing on CDRs or CCS, information about the calibration year is important.
- ➢ Updating only energy-related parameters is not recommended.
- ➢ Updating the model calibration is especially recommended when there are significant changes in the capital formation situation.