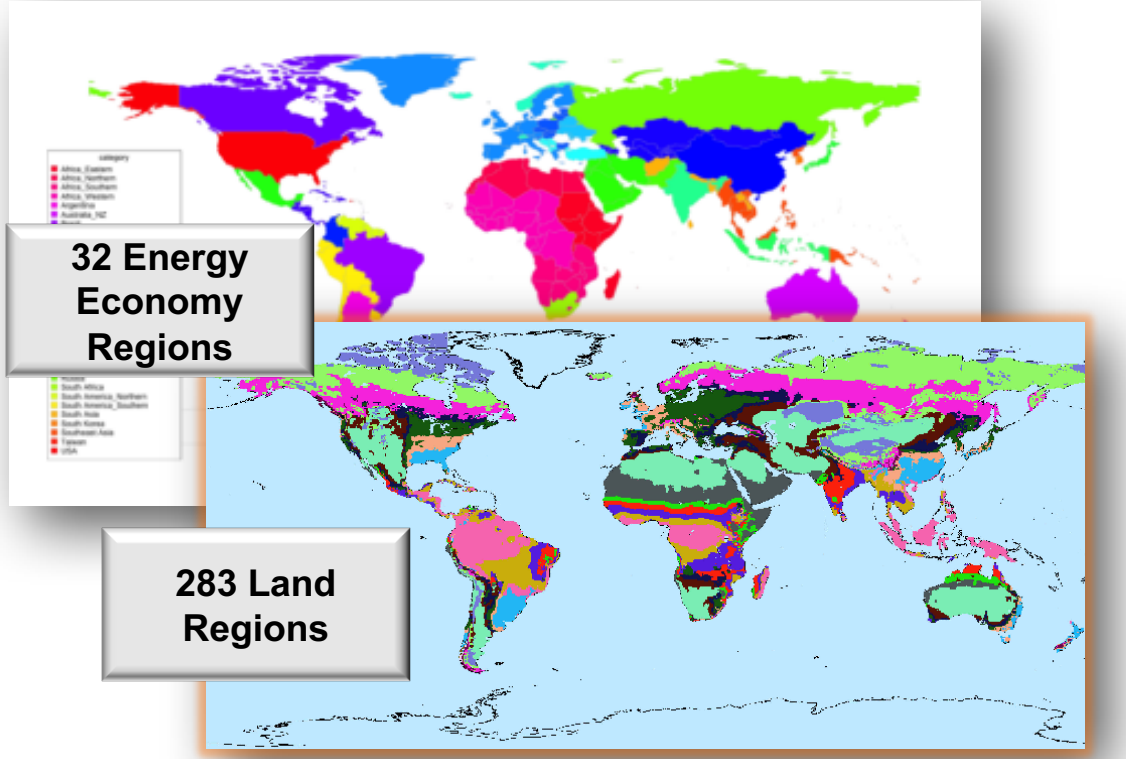
Implications of Paris Agreement for Stranded Assets in the LAC Power Sector: A Preliminary Analysis

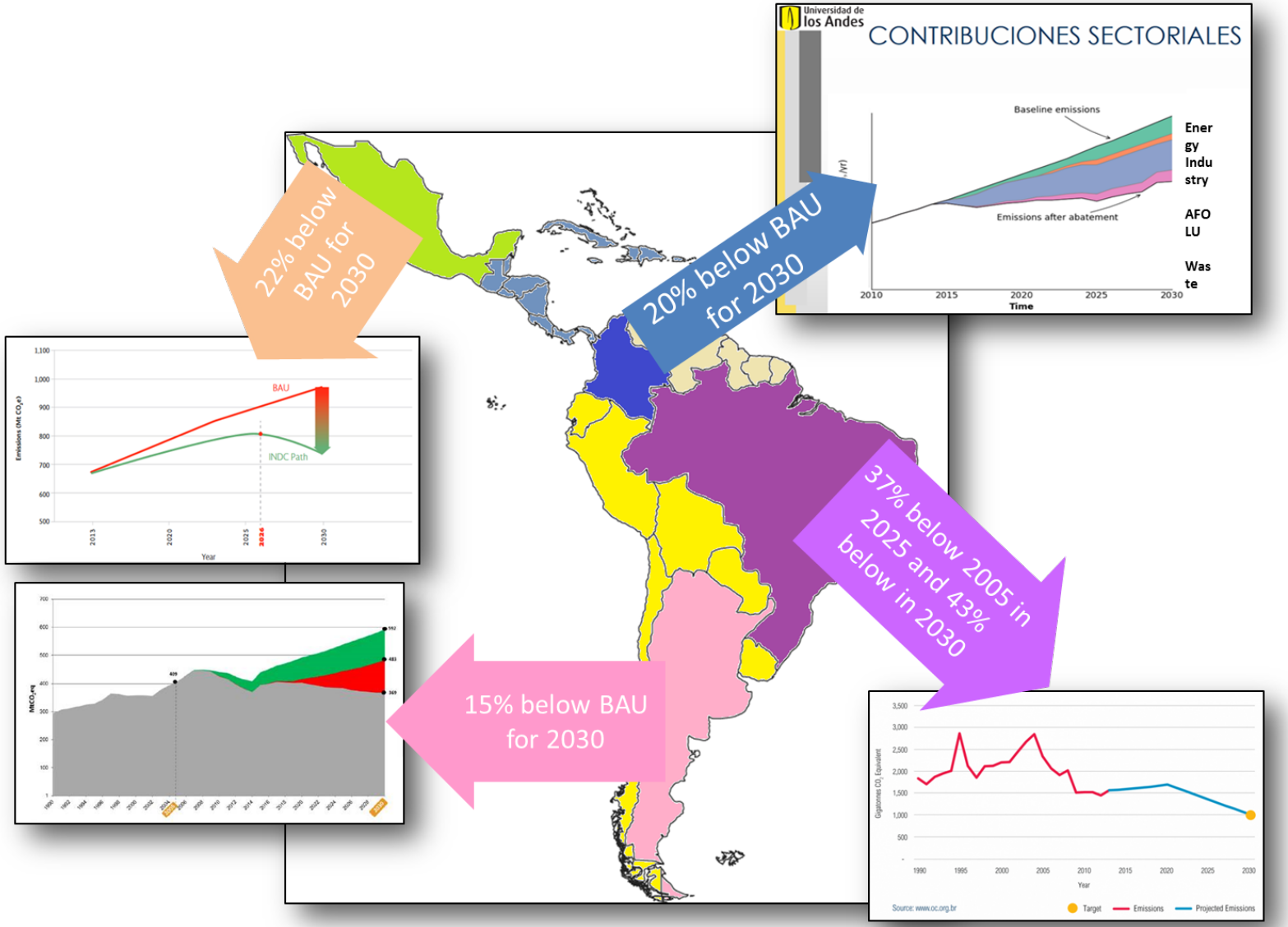
Global Change Assessment Model (GCAM)

GCAM is a highly-detailed human-Earth system model
GCAM links Economic, Energy, Land-use, and Climate systems



- Coupled in code
- Technology and sector detail
- Tracks 24 GHGs and air pollutant emissions
- Among half a dozen other models that produce scenarios used by the IPCC

Contributions of the NDCs to LAC emission reductions through 2030 vary by country



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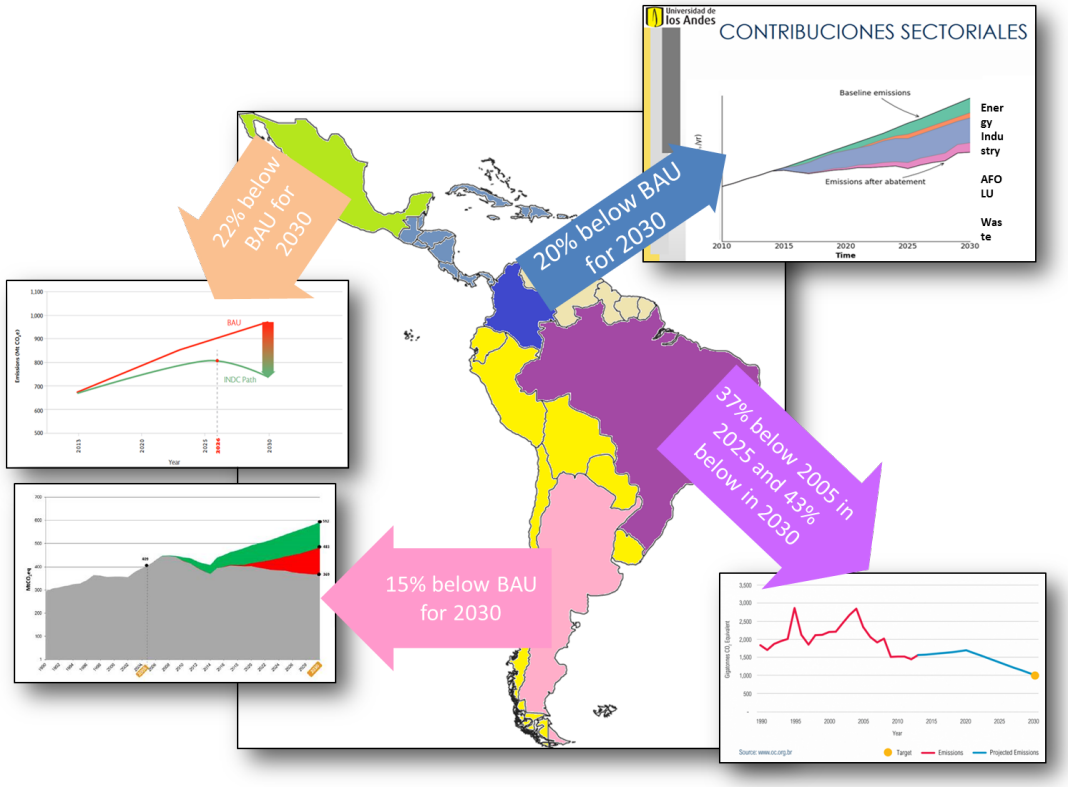
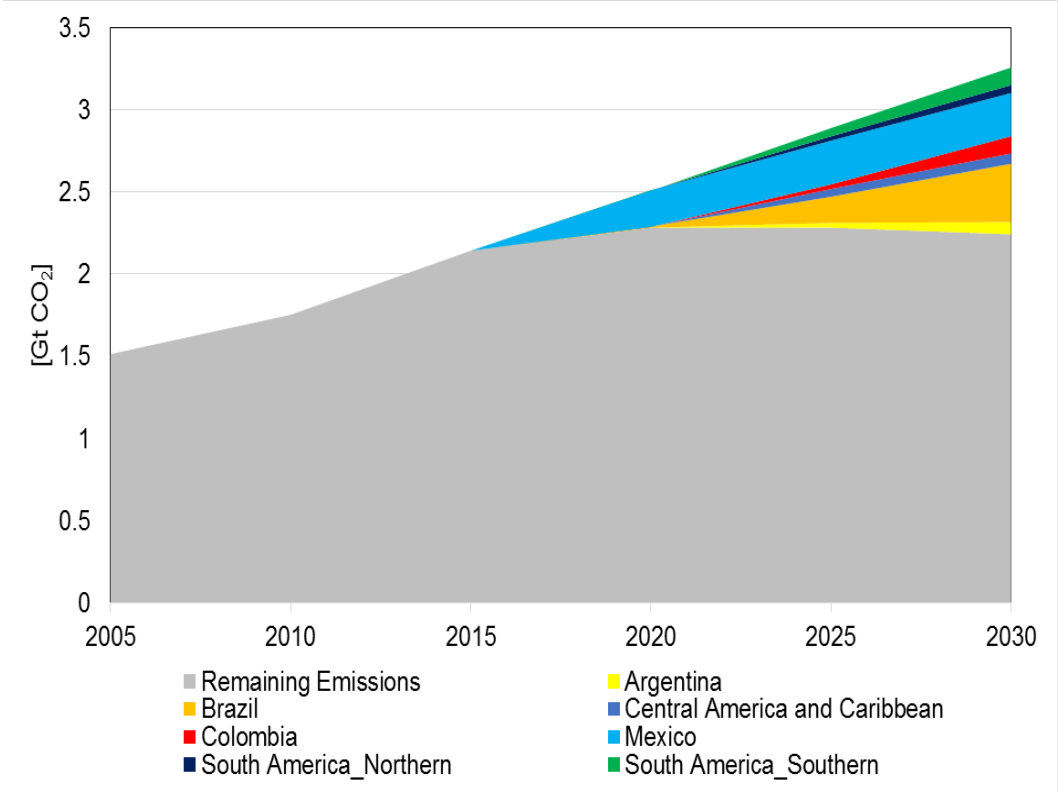
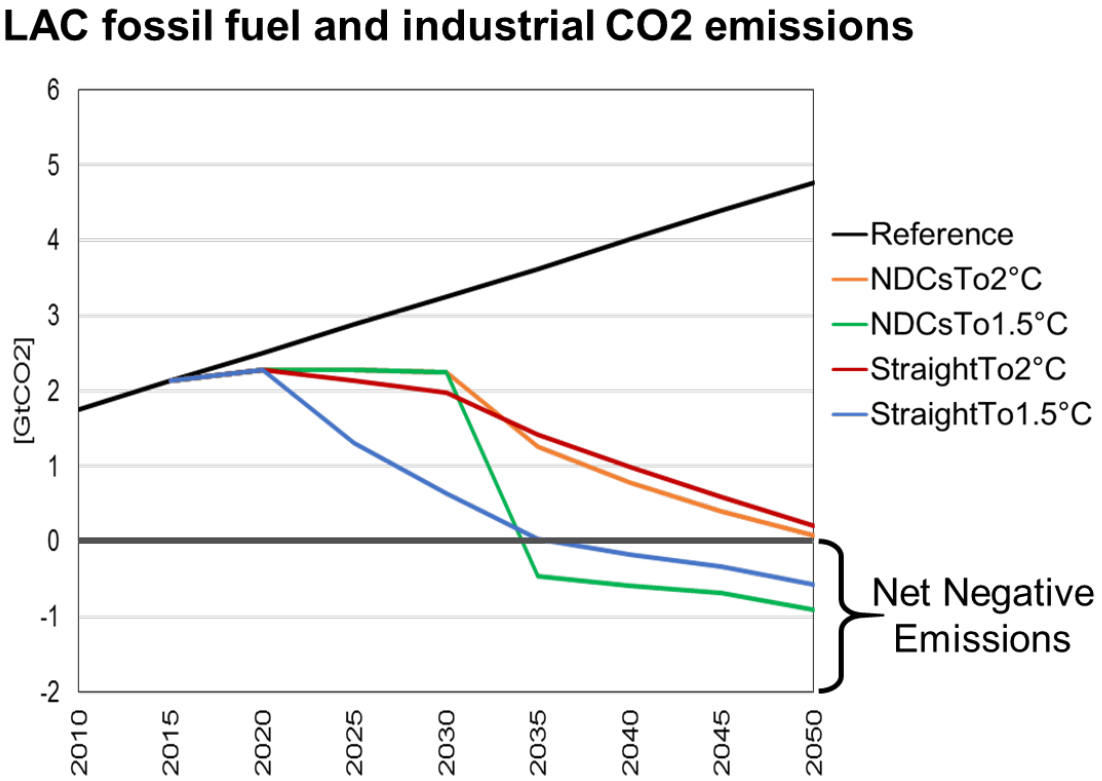


LAC fossil fuel and industrial CO_2 emissions



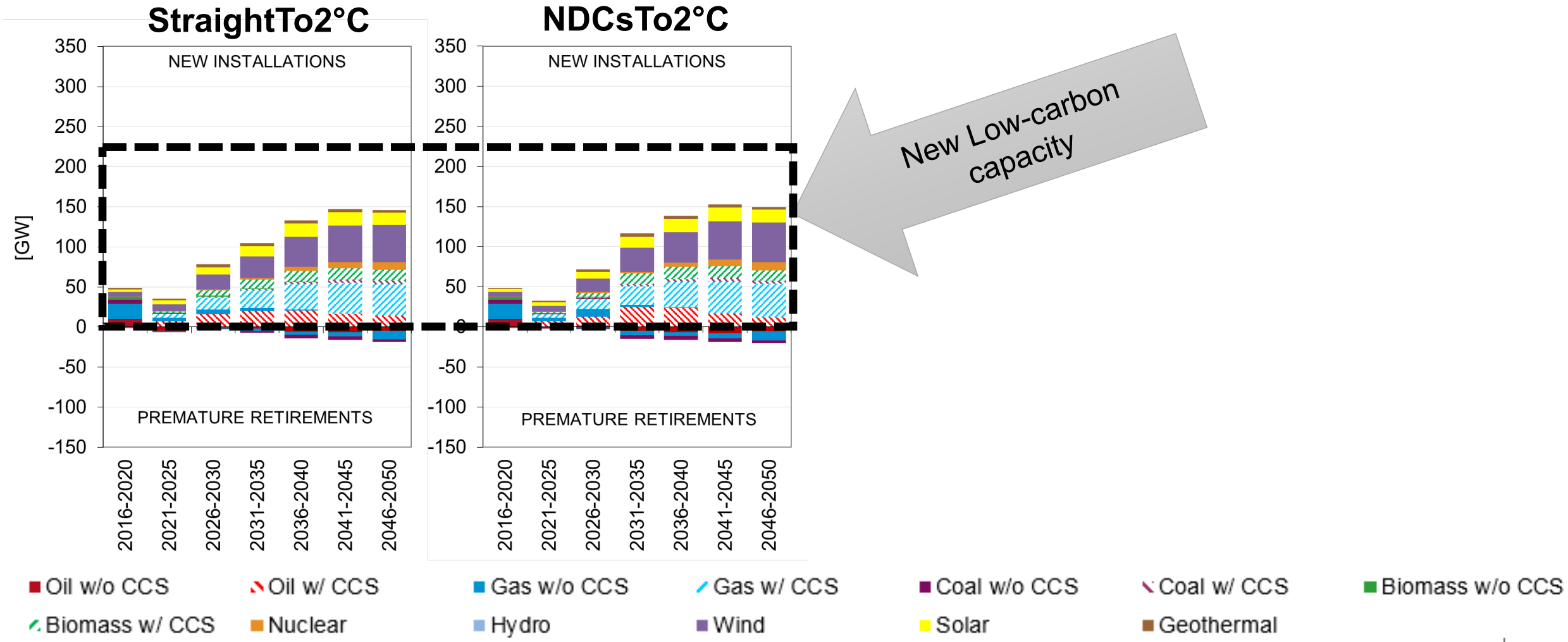
Exploratory emissions scenarios for stranded assets analysis

Scenario	2016-2020	2021-2030	Beyond 2030
NDCsTo2°C	Copenhagen	NDCs	Global cumulative CO_2 emissions budget (2011-2100) of 1000 $GtCO_2$
NDCsTo1.5°C	Copenhagen	NDCs	Global cumulative CO_2 emissions budget (2011-2100) of 400 $GtCO_2$
StraightTo2°C	Copenhagen	Global cumulative CO_2 emissions budget (2011-2100) of 1000 $GtCO_2$	
StraightTo1.5°C	Copenhagen	Global cumulative CO_2 emissions budget (2011-2100) of 400 $GtCO_2$	



Mitigation scenarios involve capacity additions and pre-mature retirements

Capacity additions and pre-mature retirements [GW] – LAC power sector



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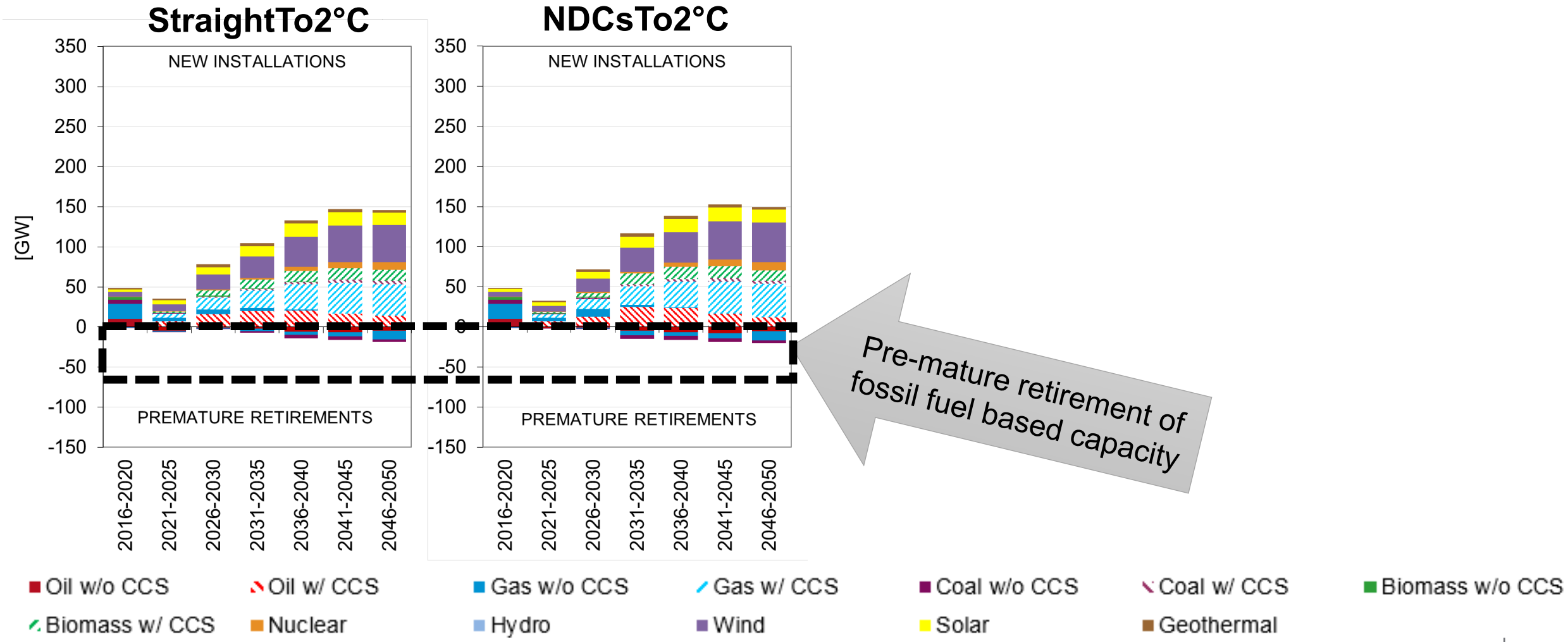

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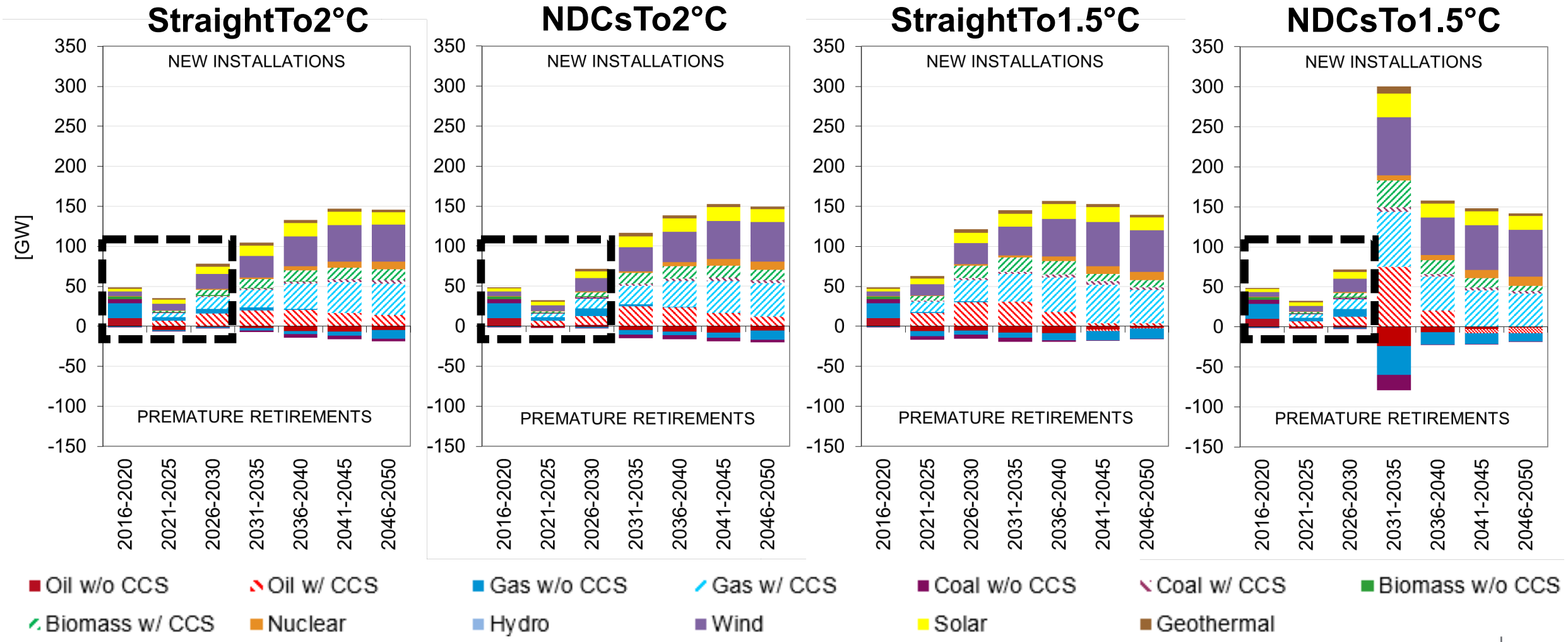
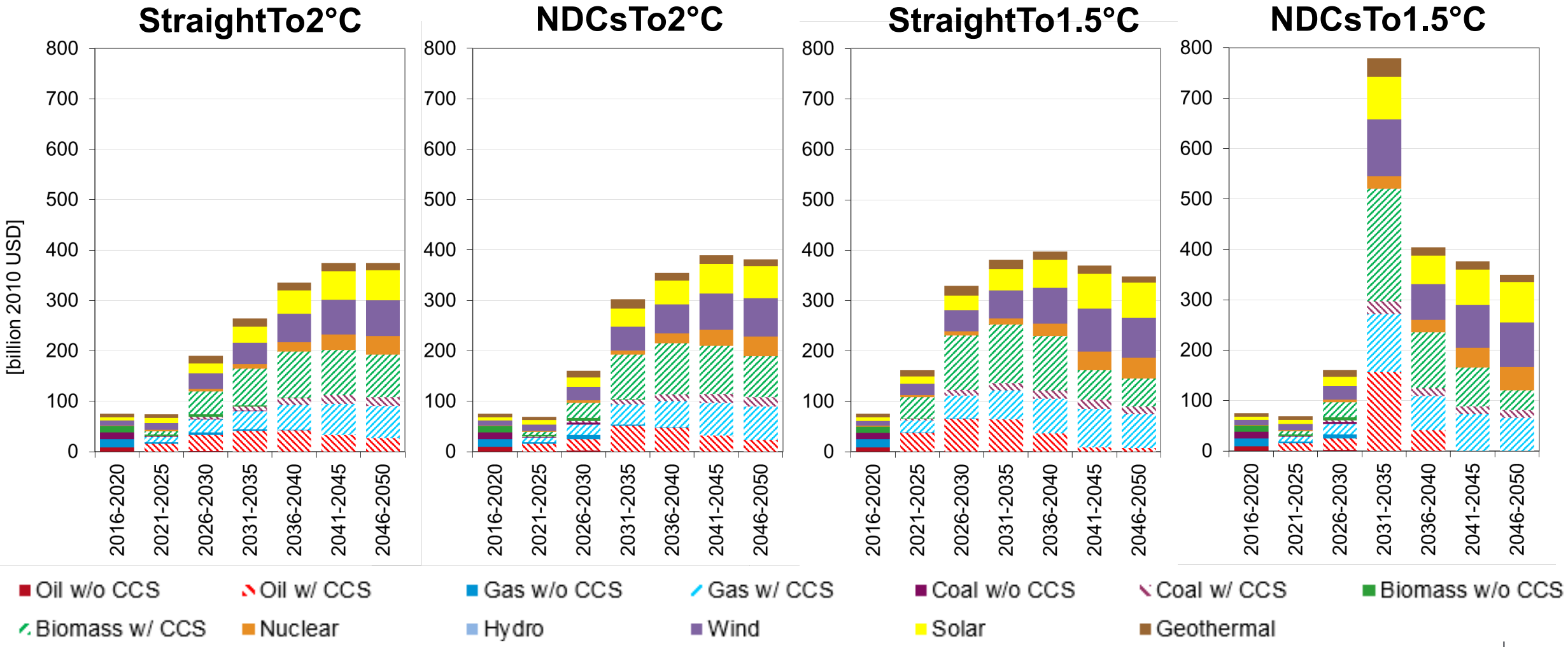


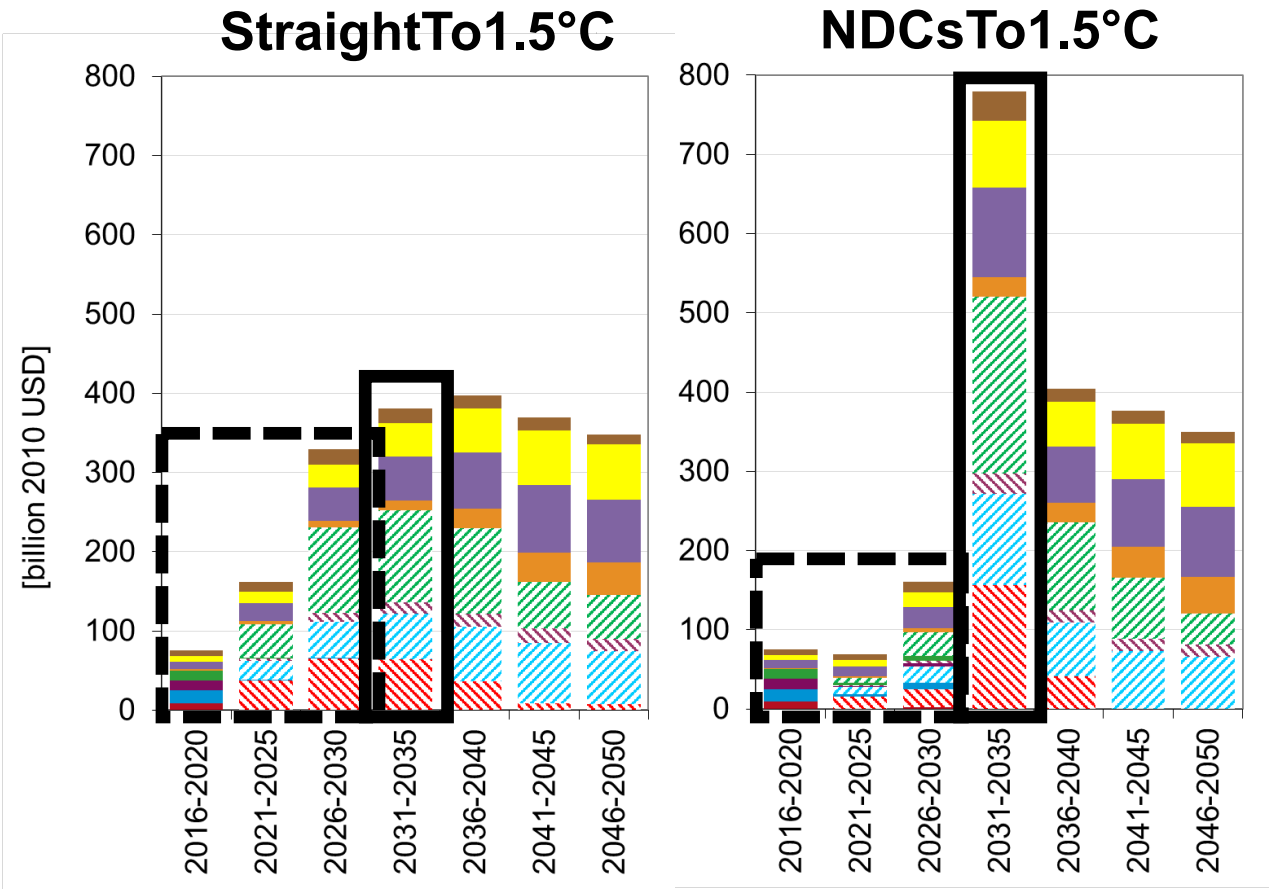
These transitions require large capital investments

Investment costs of new capacity additions – LAC power sector



Strengthening NDCs could result in substantial savings in the long-term

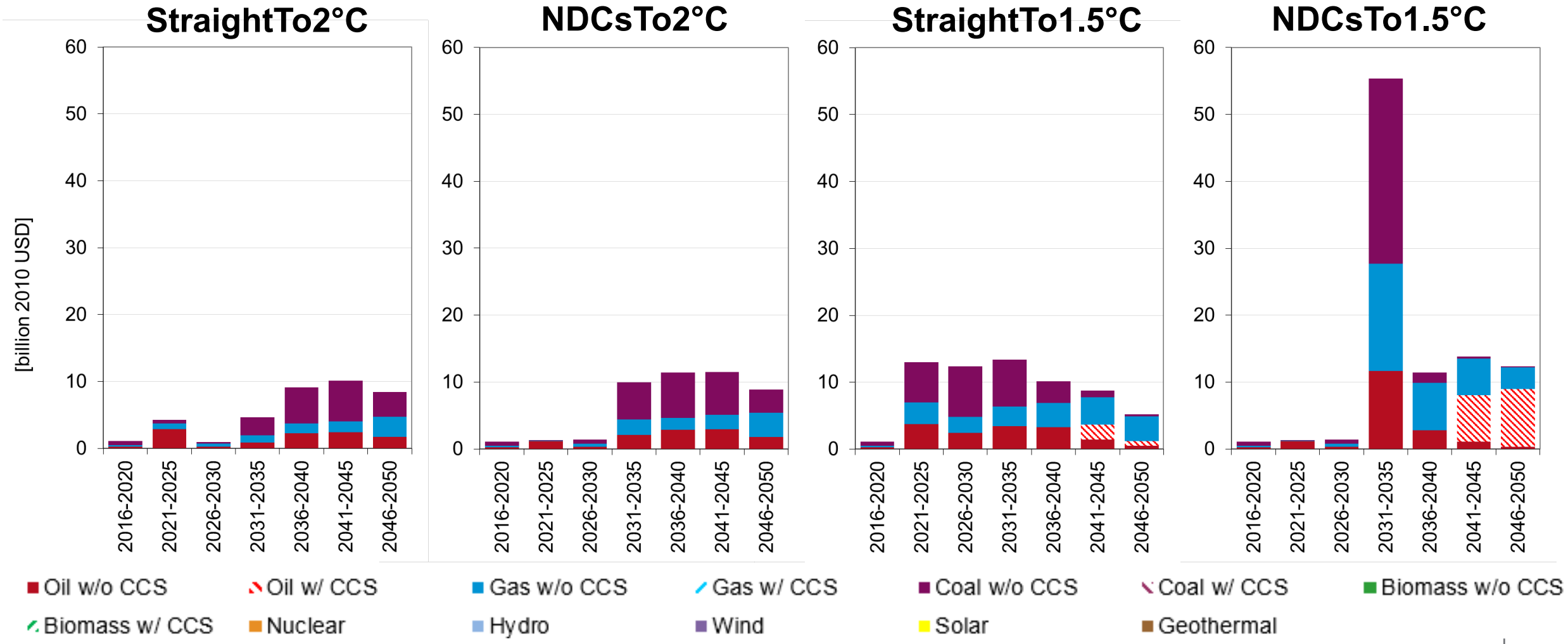
Investment costs of new capacity additions – LAC power sector



Oil w/o CCS | Oil w/ CCS | Gas w/o CCS | Gas w/ CCS | Coal w/o CCS | Coal w/ CCS | Biomass w/o CCS
Biomass w/ CCS | Nuclear | Hydro | Wind | Solar | Geothermal

Pre-maturely retired capital also has significant value

Foregone value from pre-mature retirements – LAC power sector



Summary

- Successful implementation of the Paris Agreement is expected to have important implications for stranding of fossil fuel assets.
- Stranded Assets is an important issue for LAC because of the existence of fossil fuel based energy supply.
- Achieving the long-term goals of the Paris Agreement will entail stranding of large amounts of existing fossil fuel based infrastructure resulting in economic losses.
- Strengthening the NDCs could have important implications for minimizing stranded asset and investment costs in LAC.

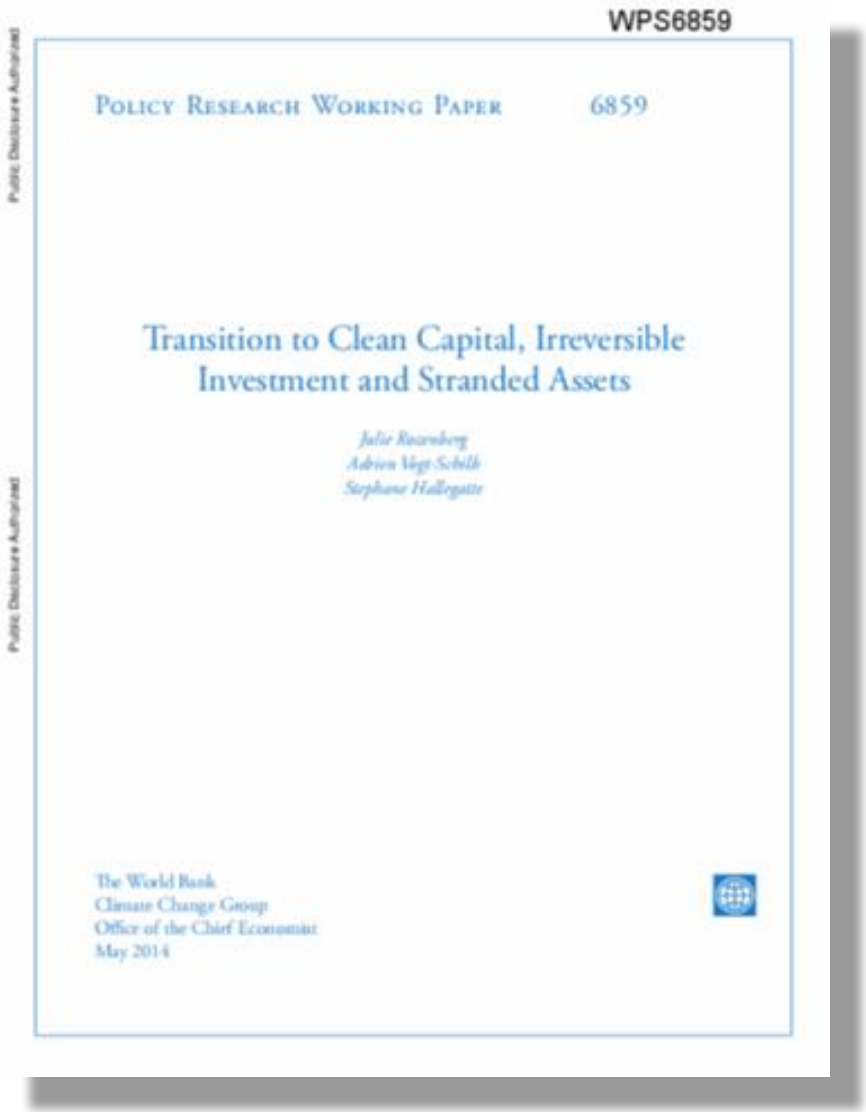
Discussion

Appendix

Category I: Implications of various policy instruments

- Rozenberg et al. (2017) compare stranded assets associated with optimal carbon pricing with those generated under second-best policies such as phased-in carbon prices and technological mandates.

- They find that although second-best policies can reduce stranded assets in the near-term, these policies are less efficient on the long-term.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POLICY RESEARCH WORKING PAPER 6859

Transition to Clean Capital, Irreversible Investment and Stranded Assets

Julie Rozenberg
Adrien Vogt-Schilb
Stéphane Hallegatte

The World Bank
Climate Change Group
Office of the Chief Economist
May 2014

Rozenberg, J., Vogt-Schilb, A., Hallegatte, S., 2017. Instrument Choice and Stranded Assets in the Transition to Clean Capital.

Category II: Commitment Accounting

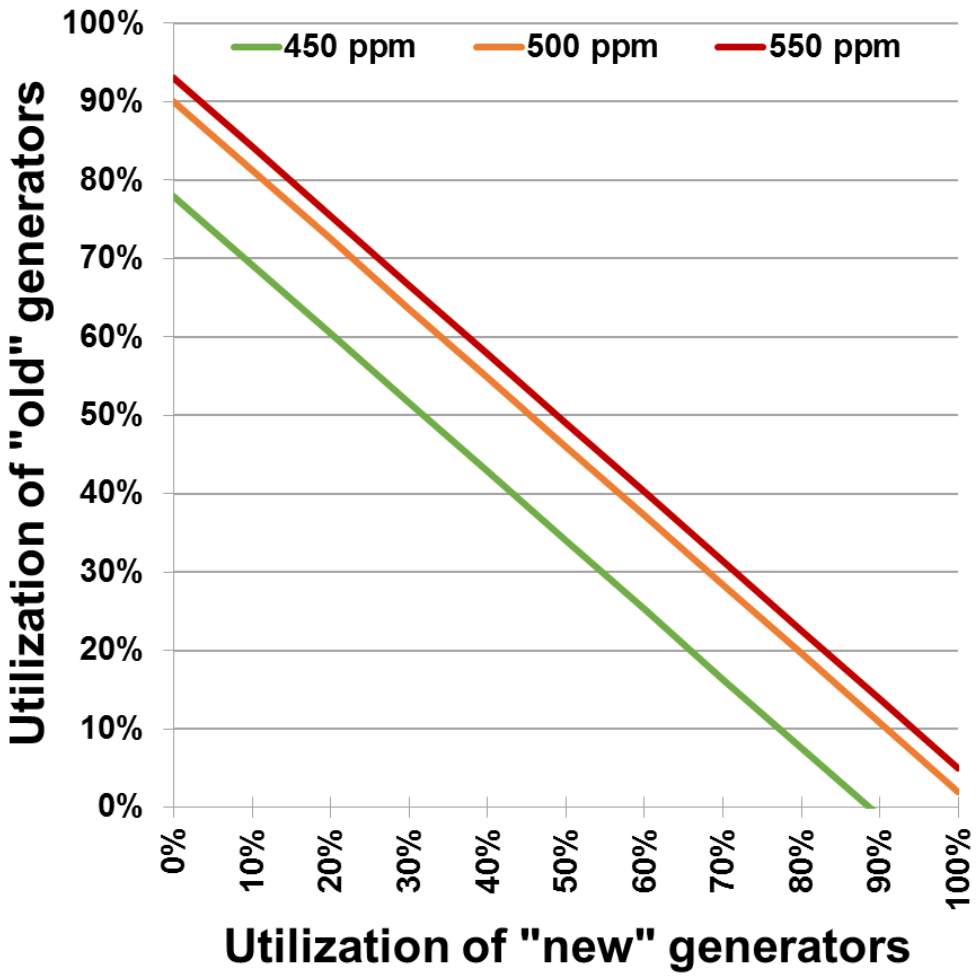
- These studies quantify expected future emissions, or “committed emissions”, implied by current investments.
- Energy sector infrastructure has long lifetimes; investments made today are likely to be operating and emitting CO_2 for decades into the future.
- Pfeiffer et al. (2016) use the “committed emissions” methodology to show that, in order to limit global mean temperature rise to 2°C, no fossil-based electricity infrastructure can be built after 2017, unless other electricity infrastructure is retired early or retrofitted with carbon capture and storage (CCS) technologies.

https://inhabitat.com/supreme-court-freezes-obamas-plan-to-cut-co2-emissions/

Pfeiffer, A., Millar, R., Hepburn, C., Beinhocker, E., 2016. The ‘2°C capital stock’ for electricity generation: Committed cumulative carbon emissions from the electricity generation sector and the transition to a green economy. Applied Energy 179, 1395-1408.

Stranding some existing power plants is necessary to meet Paris goals

- Currently operating generators would already commit us to more carbon emissions than compatible with the average 1.5-2°C scenario.
- The current pipeline of power plants would add close to the same amount of additional commitments.
- Even if the entire pipeline would be cancelled, a stranding of ~20% of global capacity could be necessary to meet the climate goals set out in the Paris agreement.



Pfeiffer, A. Hepburn, C., and A. Vogt-Schilb. The 2016 Global Electricity Generation Capital Stock: Current, future, and stranded committed CO_2 emissions. ***PRELIMINARY, UNPUBLISHED ANAYLSIS.***

Category III: Implications of near-term mitigation policy stringency

- Studies in this category use integrated assessment models to assess the implications of different levels of near-term mitigation policy stringency under constraints on long-term cumulative emissions budgets.

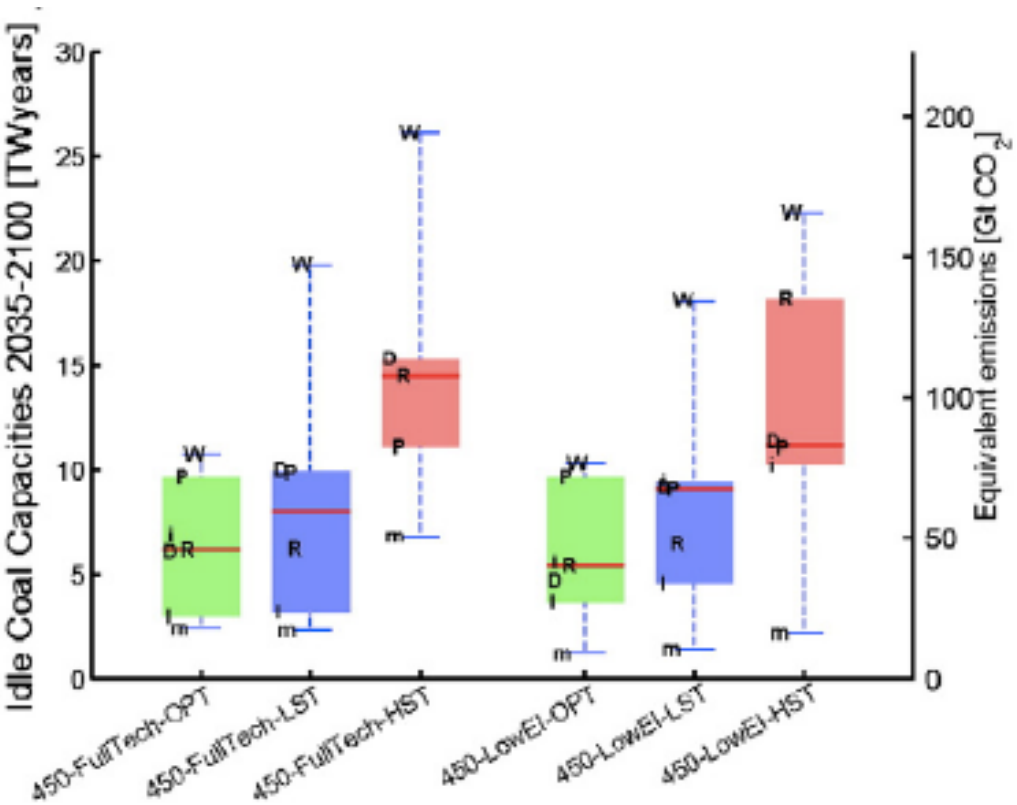
- These studies largely focus on global stranded assets in the electric power sector.

https://corporateeurope.org/pressreleases/2015/07/eu-emissions-trading-system-post-2020-proposals-lock-another-decade-failed

Weaker near-term climate policies can lead to "carbon lock-in"

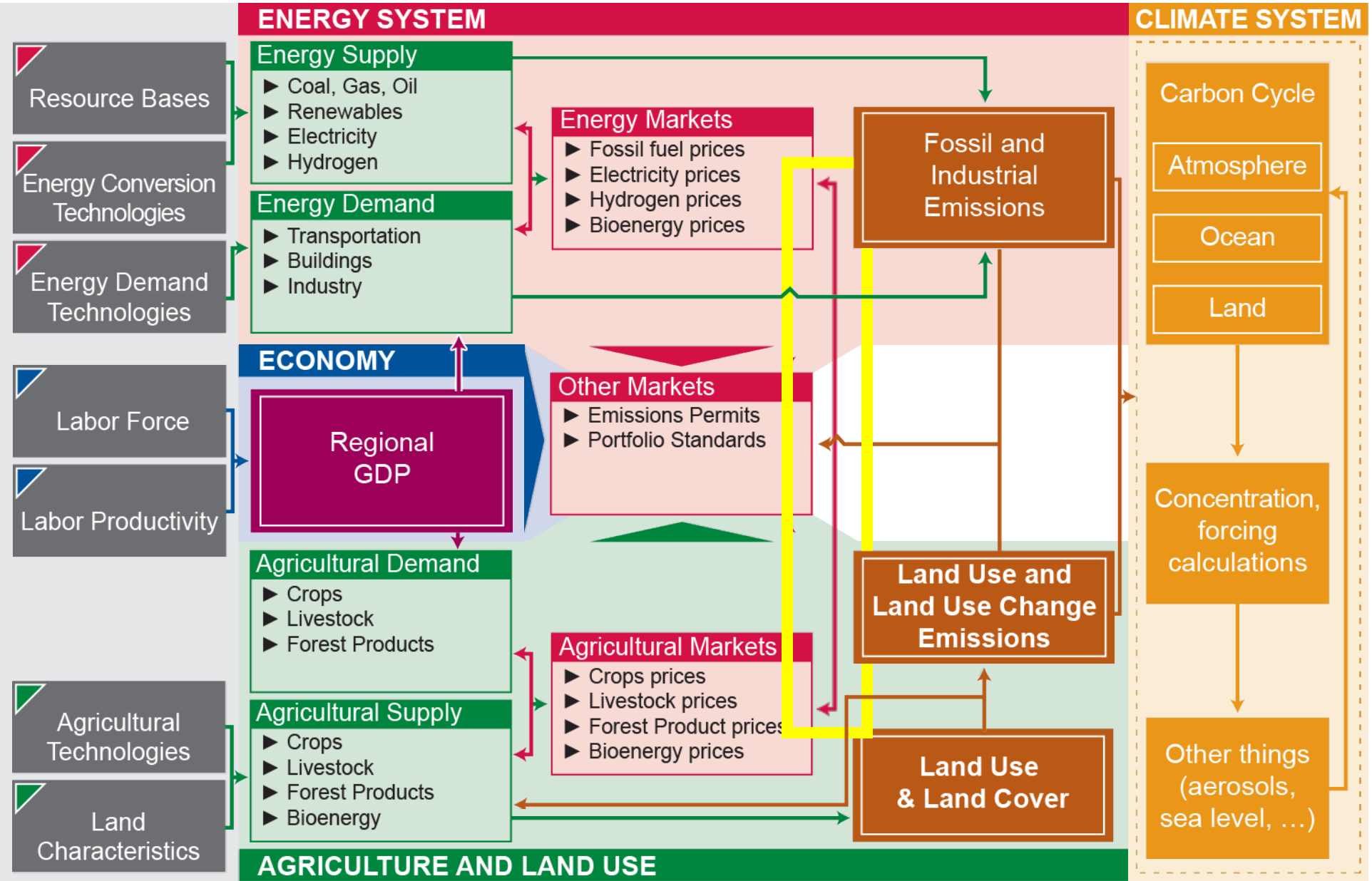
- Coal-based generation increases under weaker short-term mitigation policy scenarios which can result in significant carbon lock-in through capital stock inertia and greater stranded assets in the long-term.

- Mitigation scenarios which focus on reducing emissions intensity result in lower stranded assets.

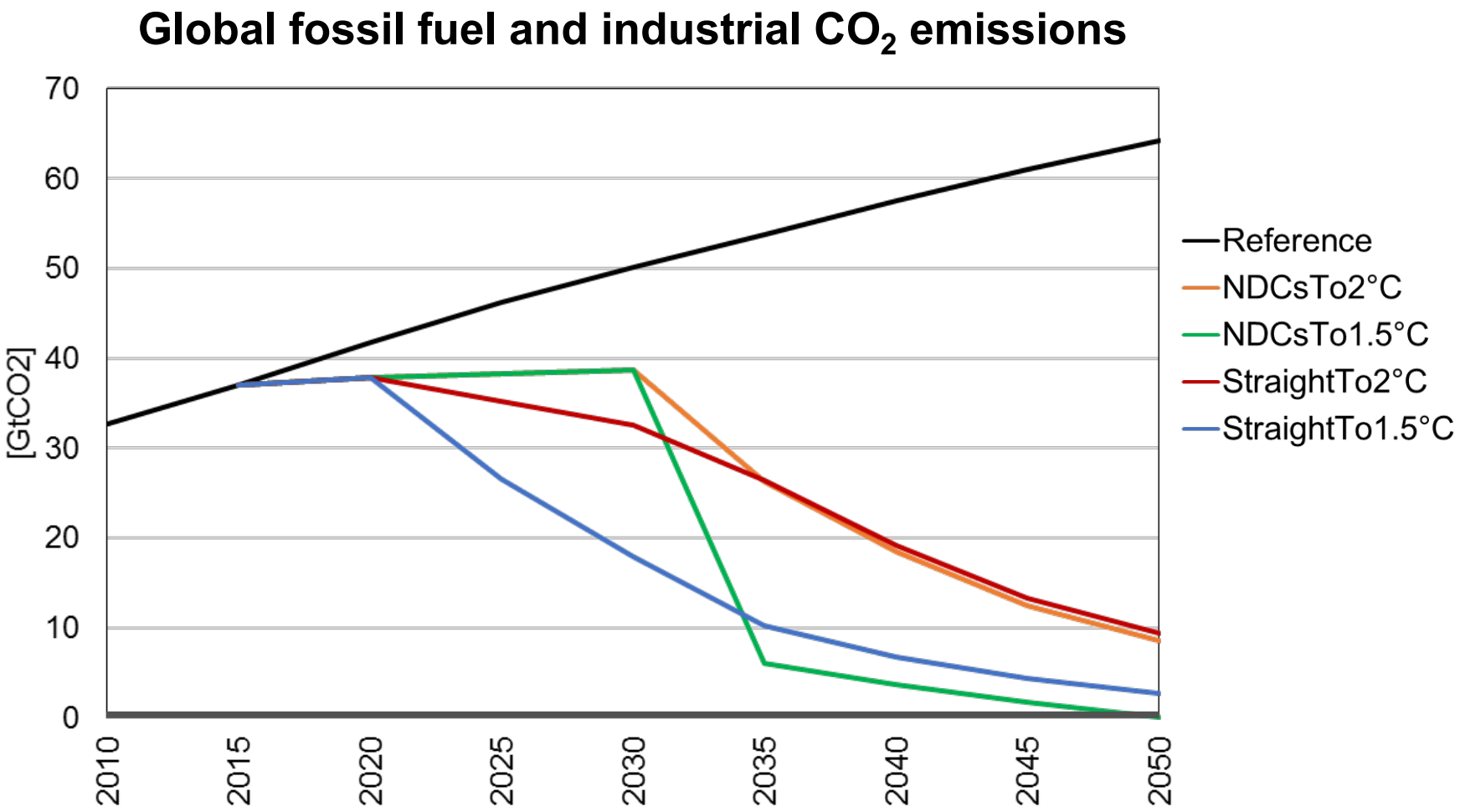


Bertram, C., Johnson, N., et.al. 2015. Carbon lock-in through capital stock inertia associated with weak near-term climate policies. Technological Forecasting and Social Change 90, 62-72.

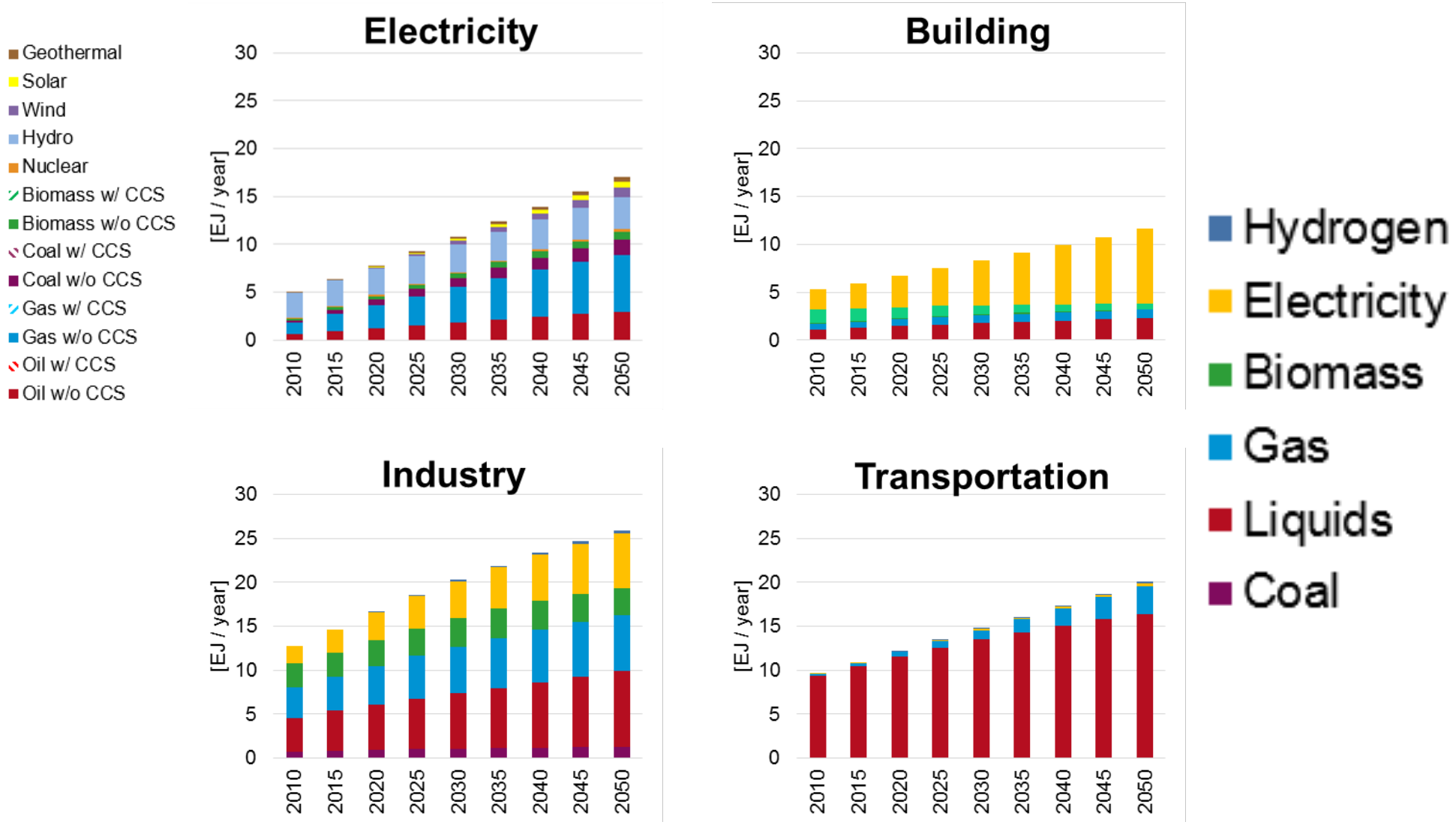
Overview of GCAM



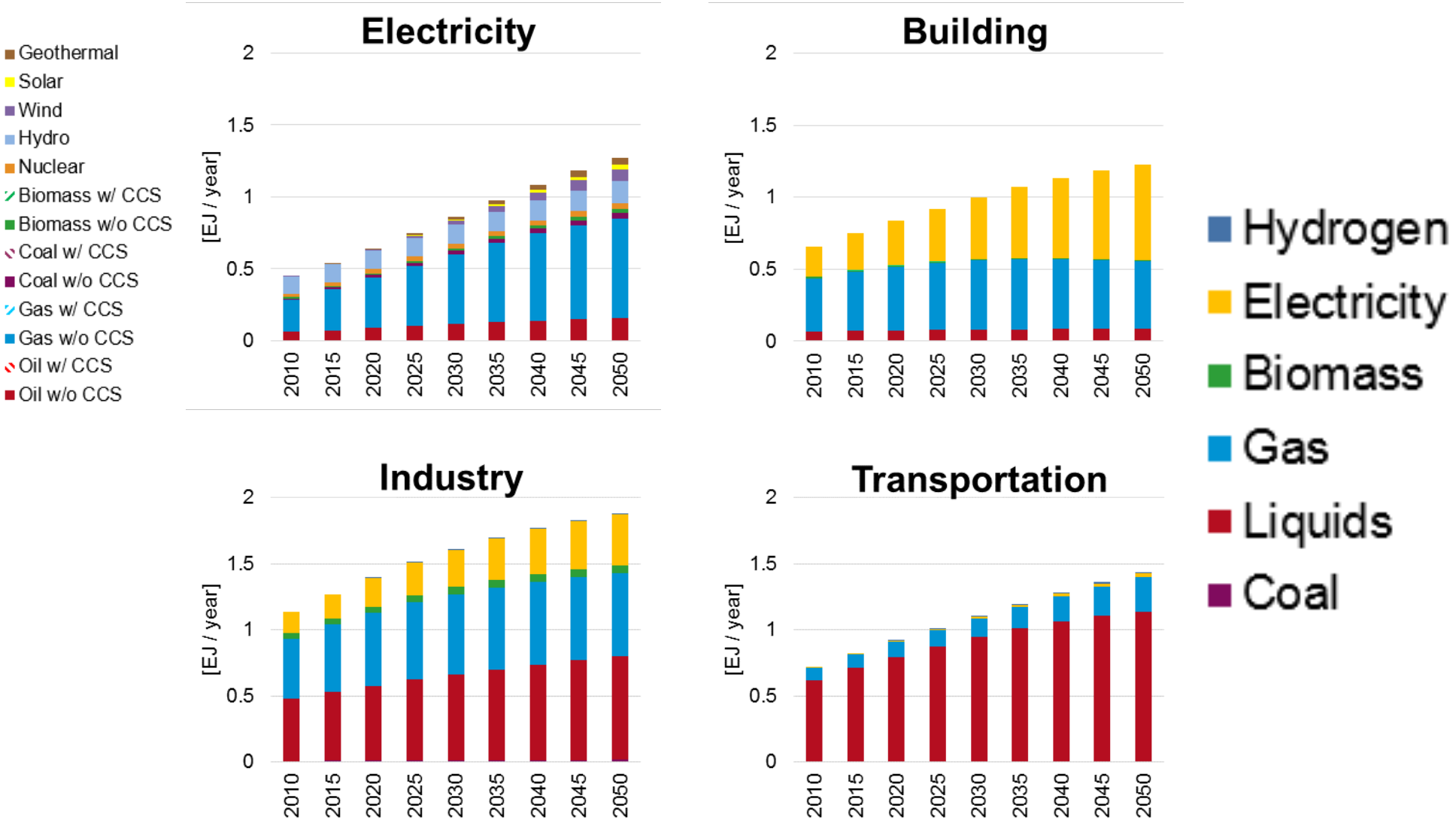
Global fossil fuel and industrial CO_2 emissions



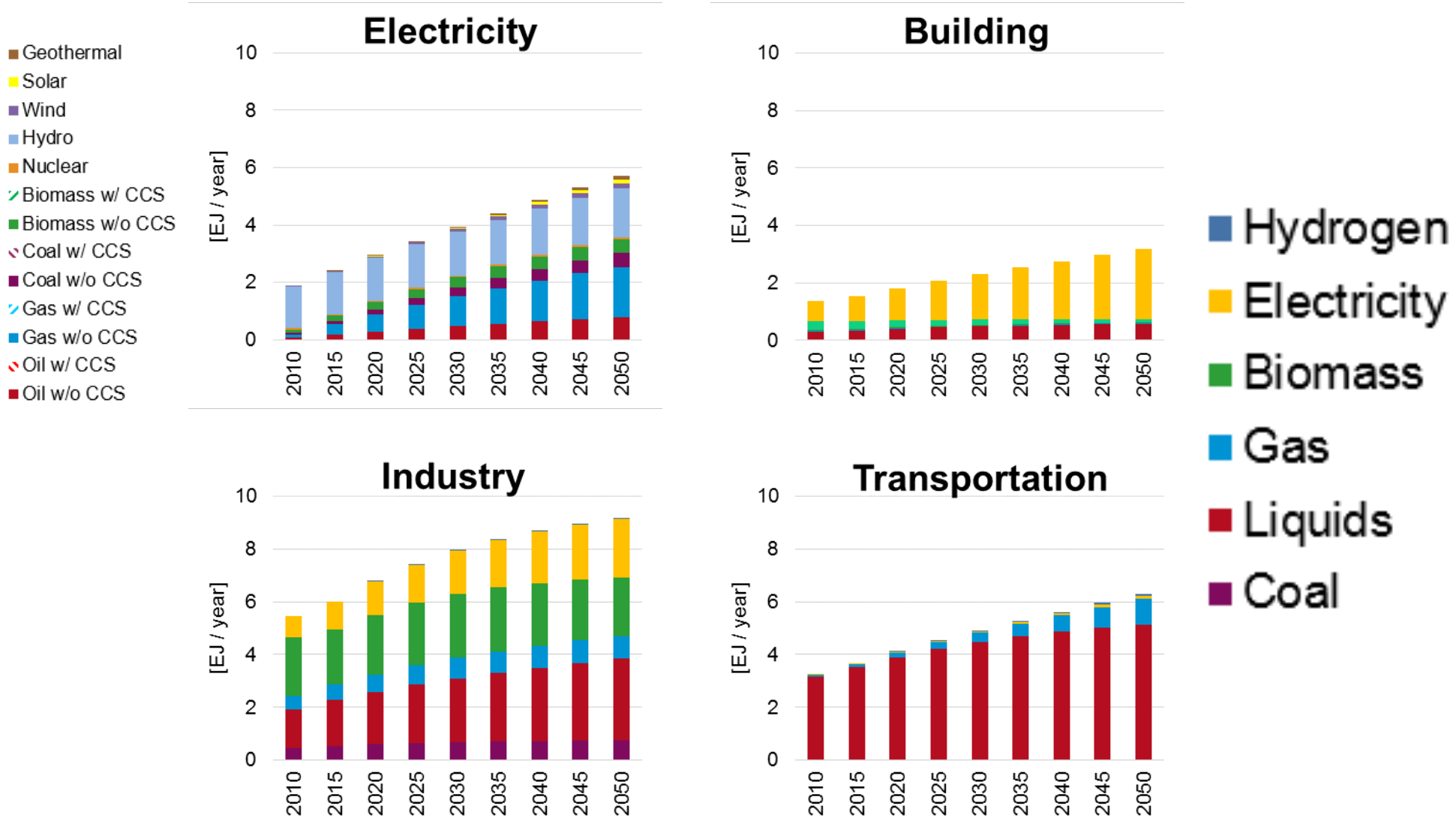
Electricity Generation, Final Energy Consumption LAC – Reference scenario



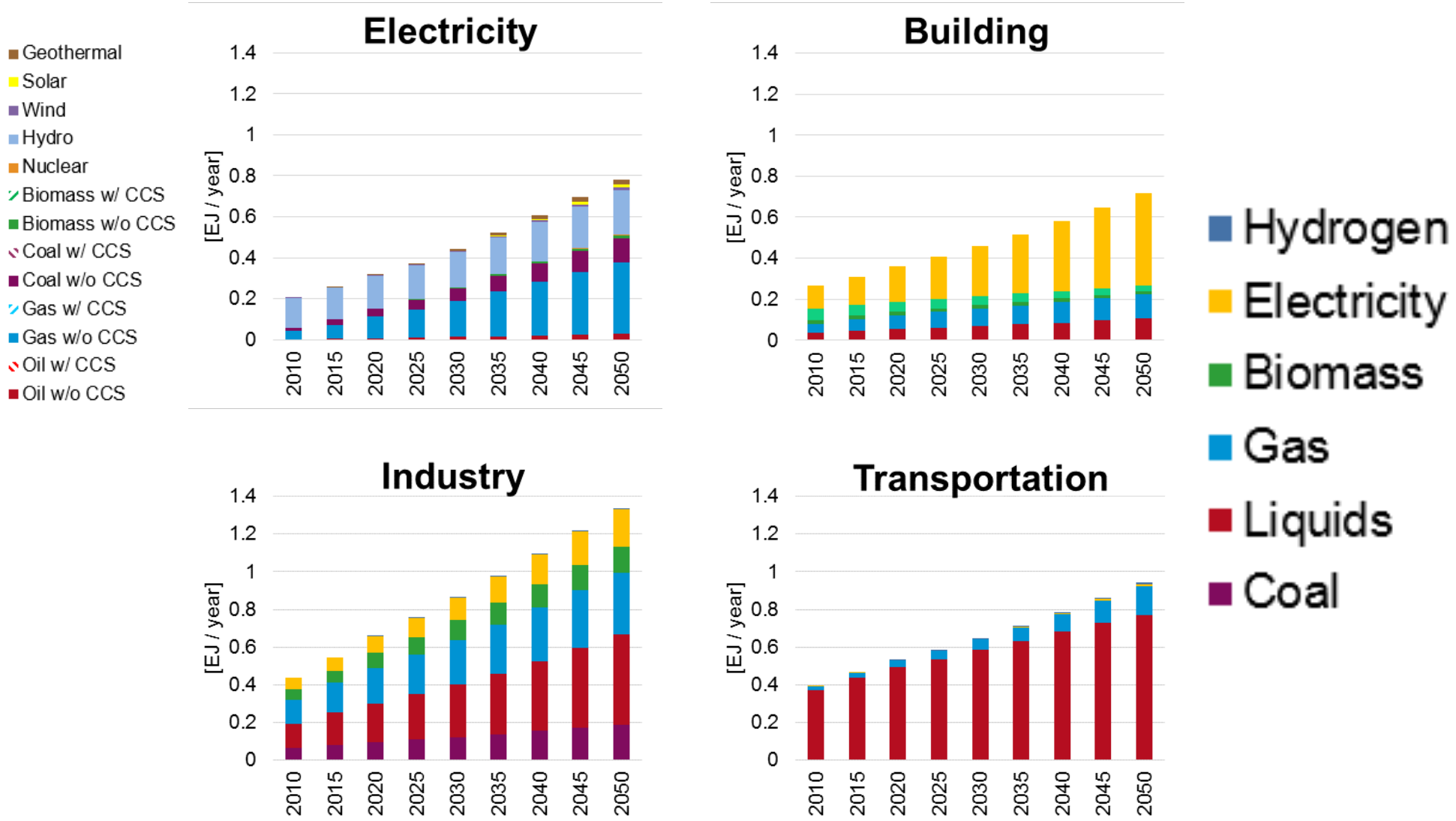
Electricity Generation, Final Energy Consumption Argentina – Reference scenario



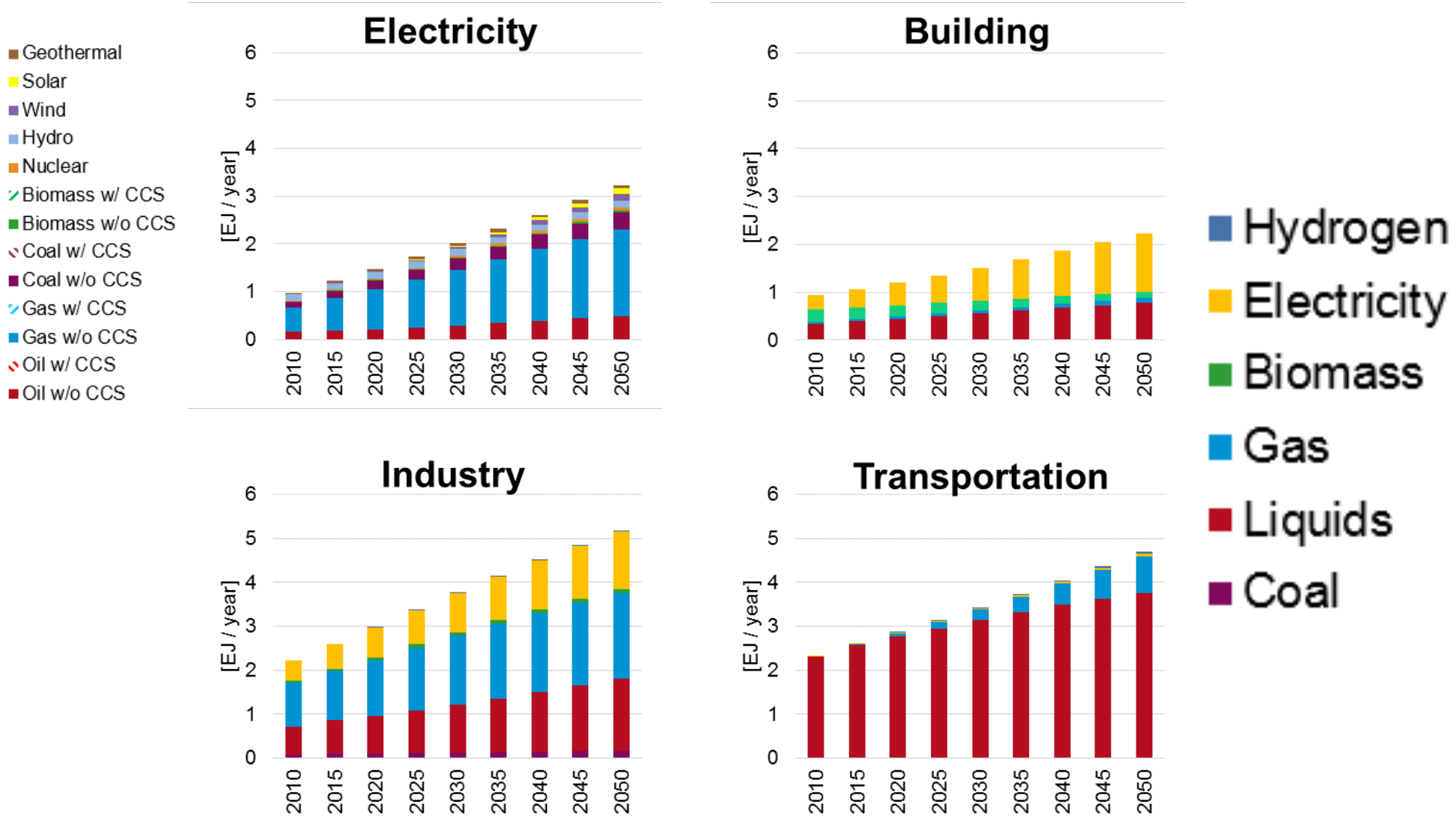
Electricity Generation, Final Energy Consumption Brazil – Reference scenario



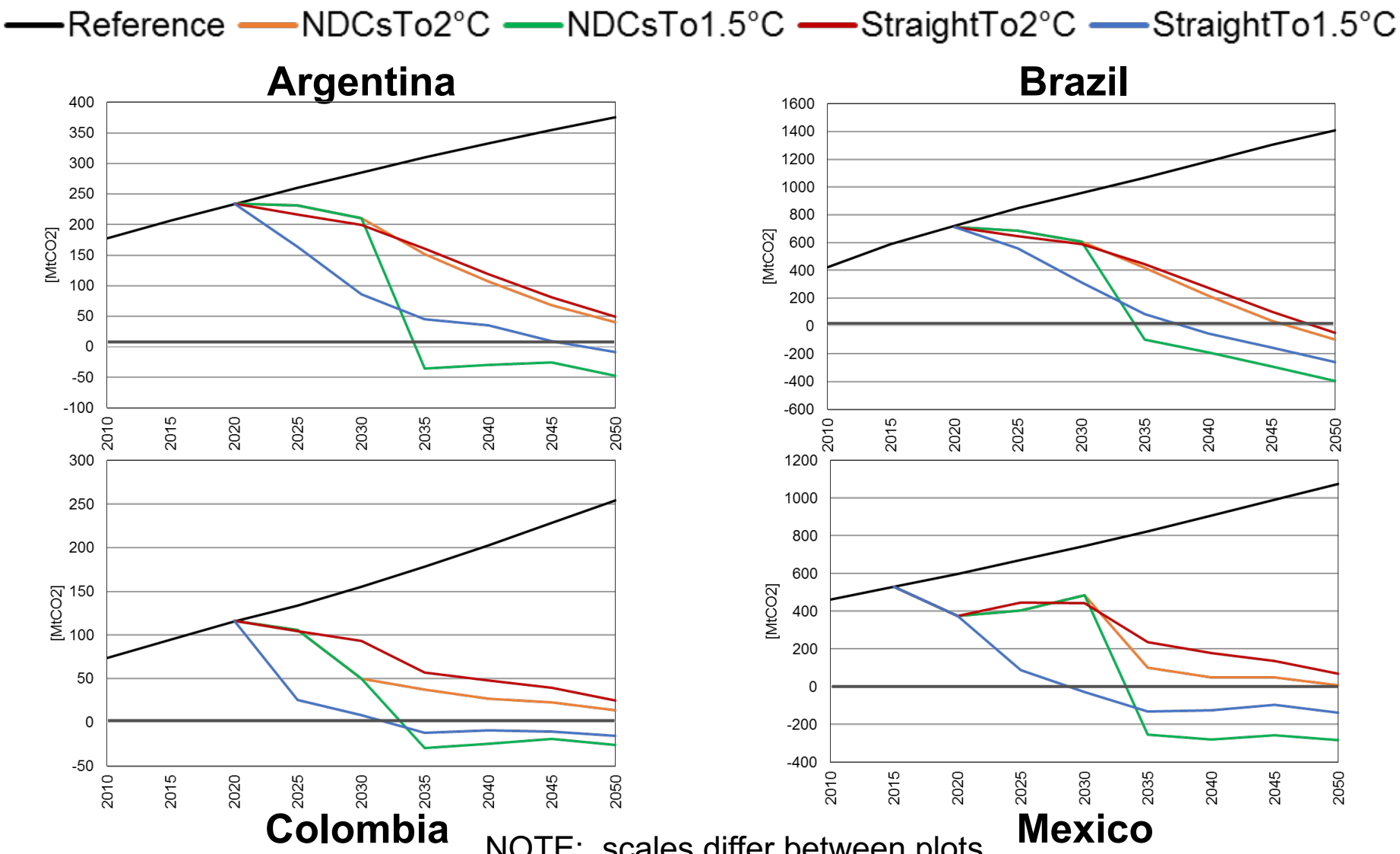
Electricity Generation, Final Energy Consumption Colombia – Reference scenario



Electricity Generation, Final Energy Consumption Mexico – Reference scenario



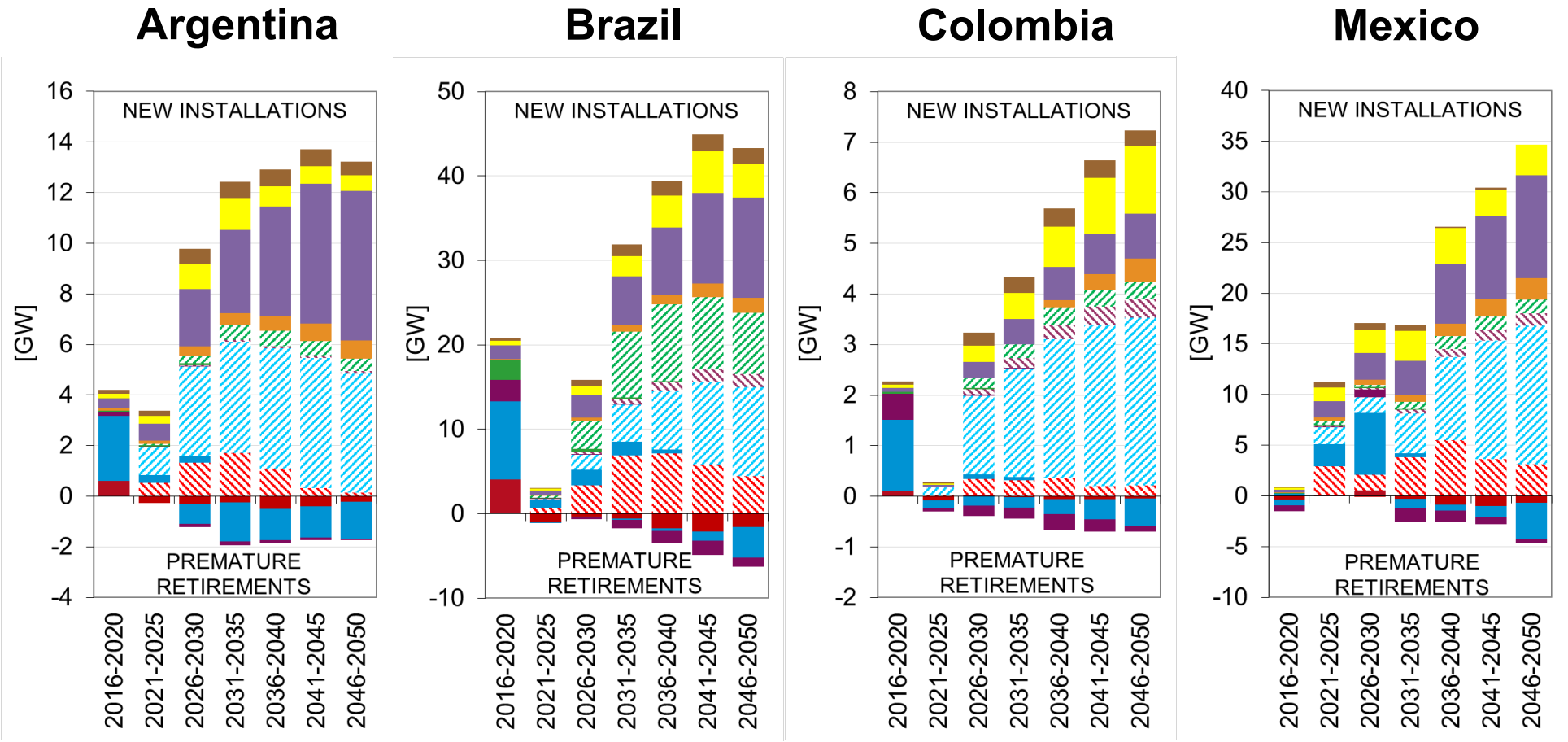
Fossil fuel and industrial CO_2 emissions pathways vary by country



NOTE: scales differ between plots

The magnitudes of capacity additions and pre-mature retirements vary by country

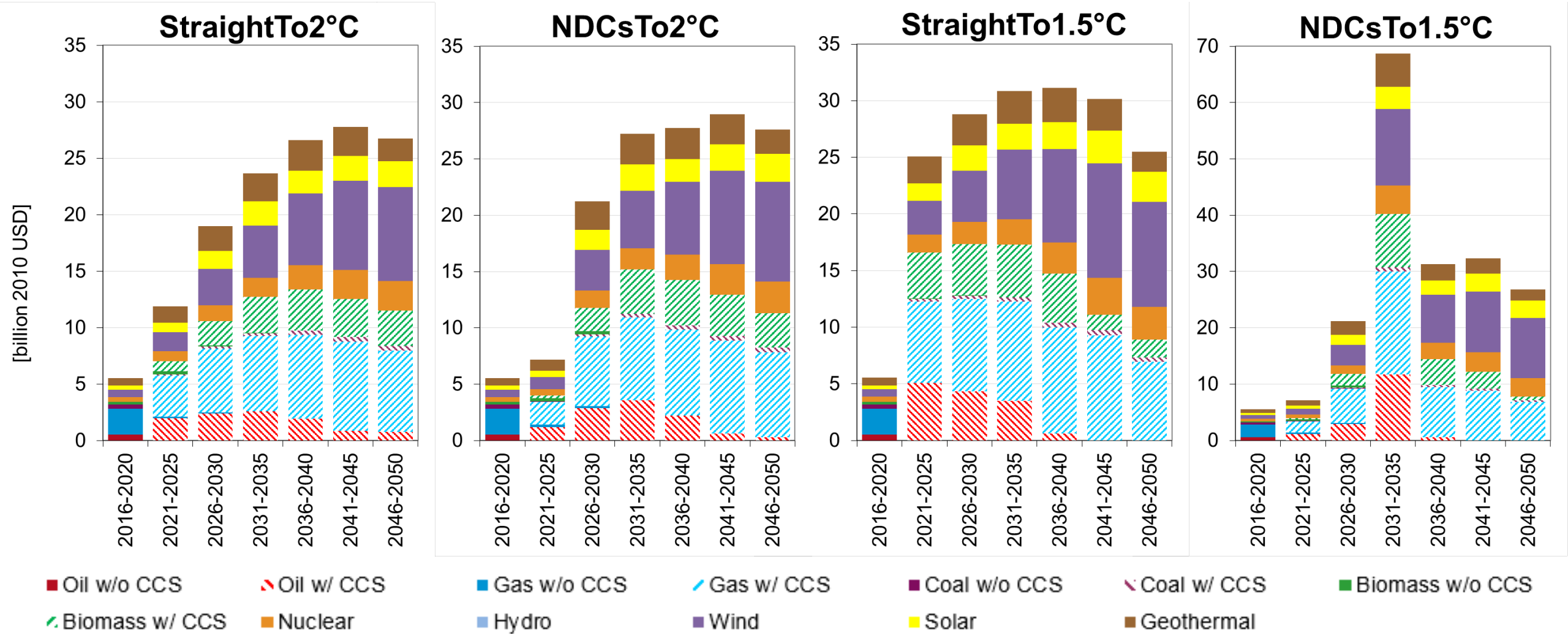
Annual installations & retirements – power sector



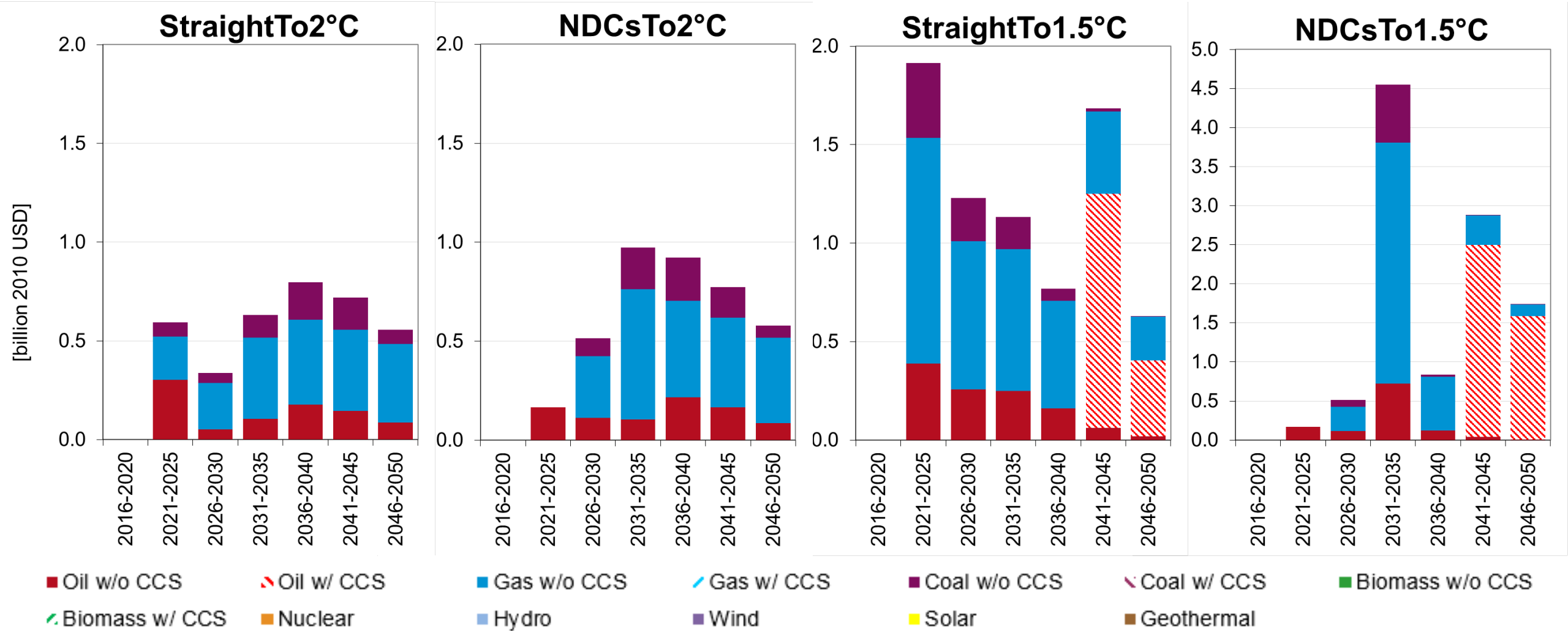
NDCsTo2°C

NOTE: scales differ between plots

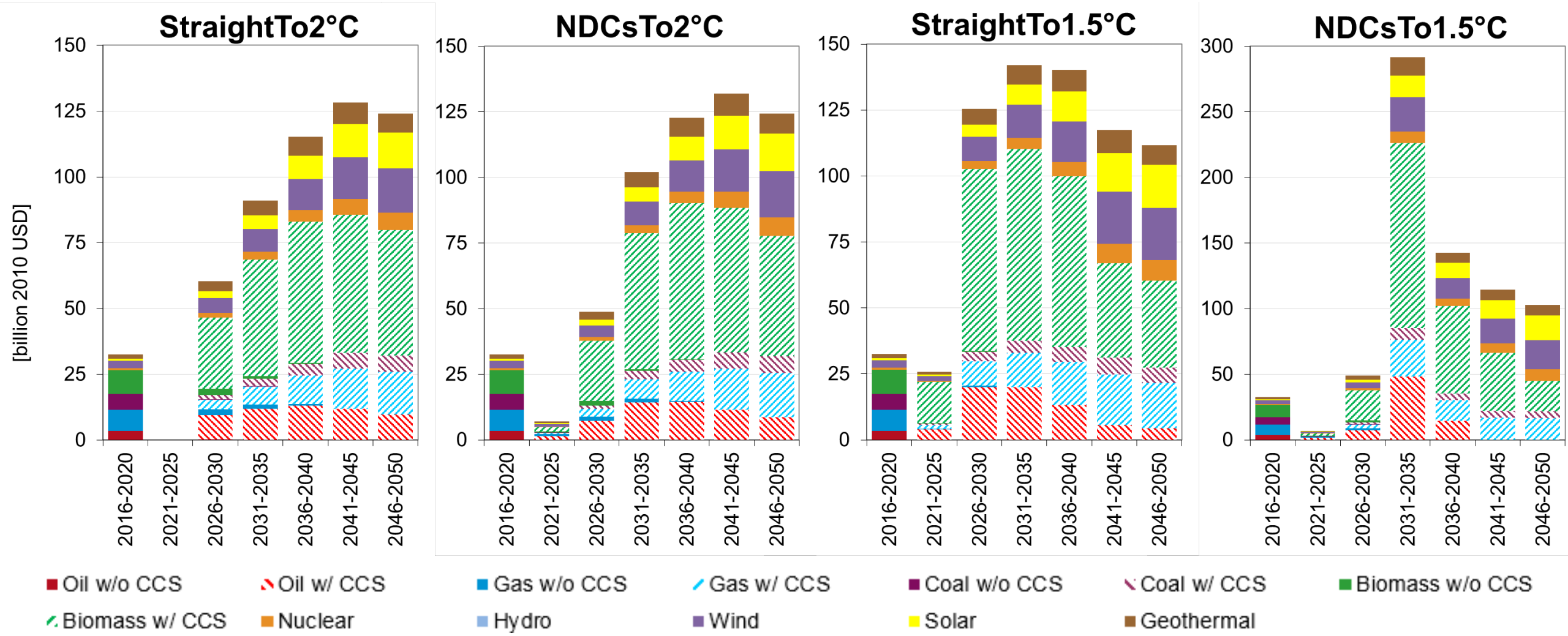
Capital Investment Requirements – Argentina



Foregone Value of Stranded Assets – Argentina



Capital Investment Requirements – Brazil



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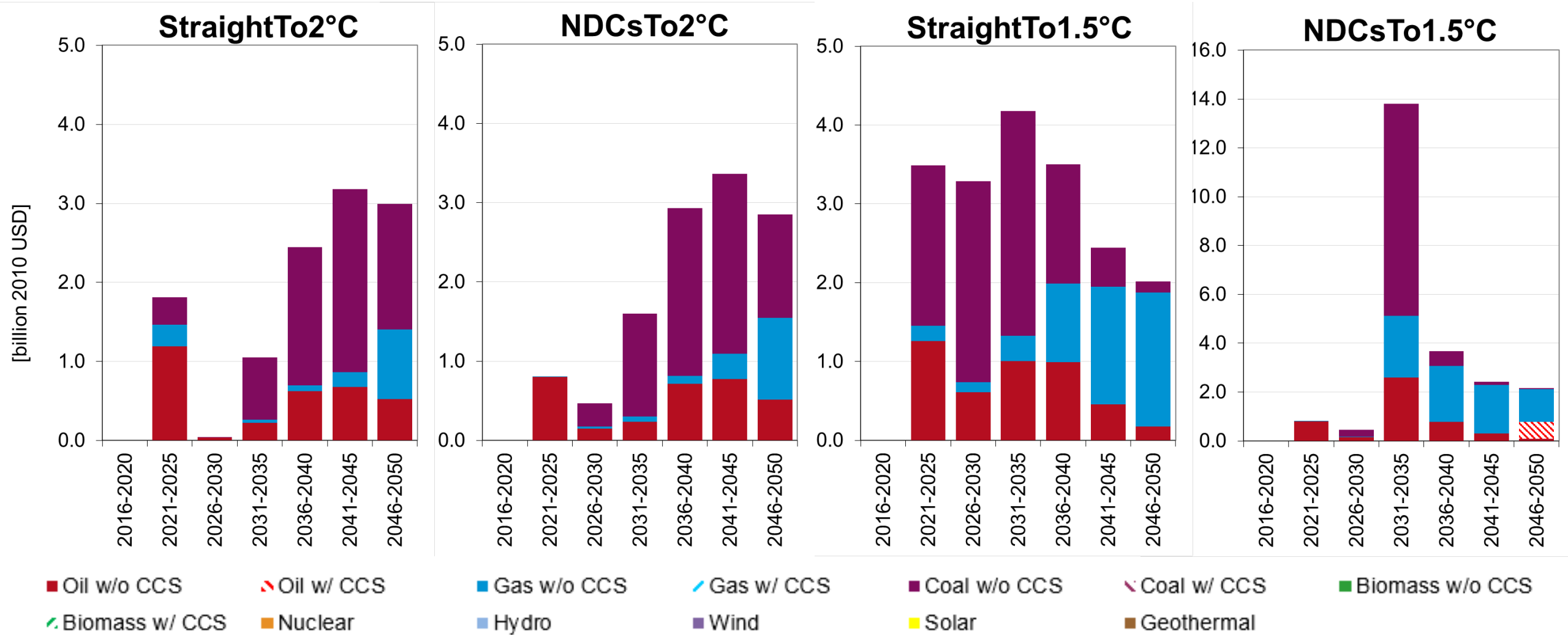
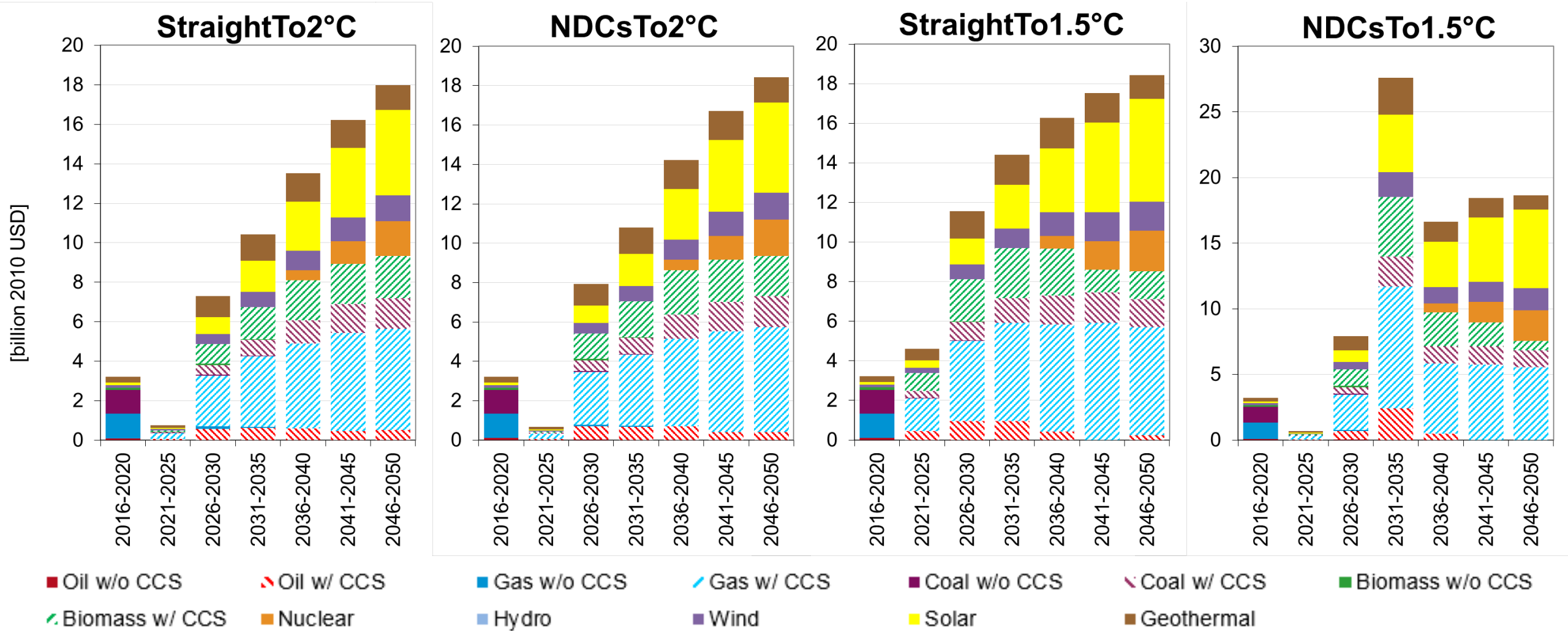


Capital Investment Requirements – Colombia



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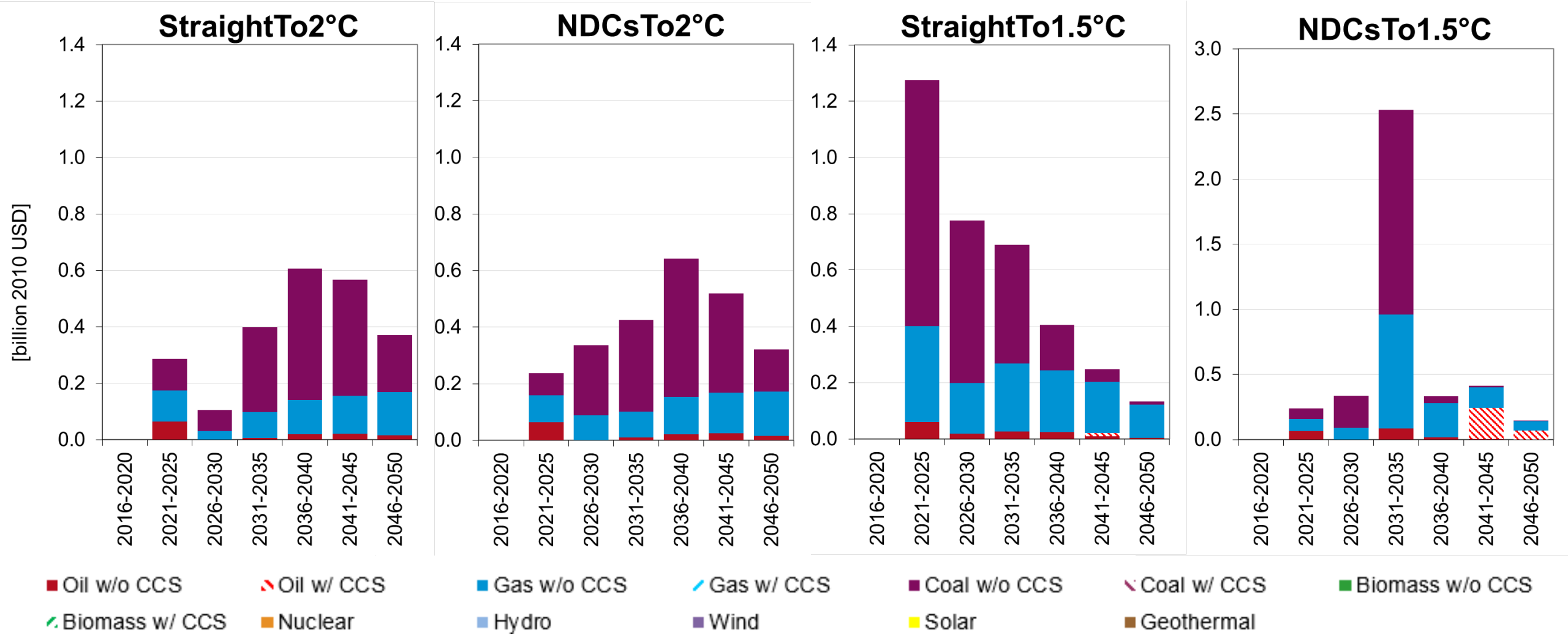
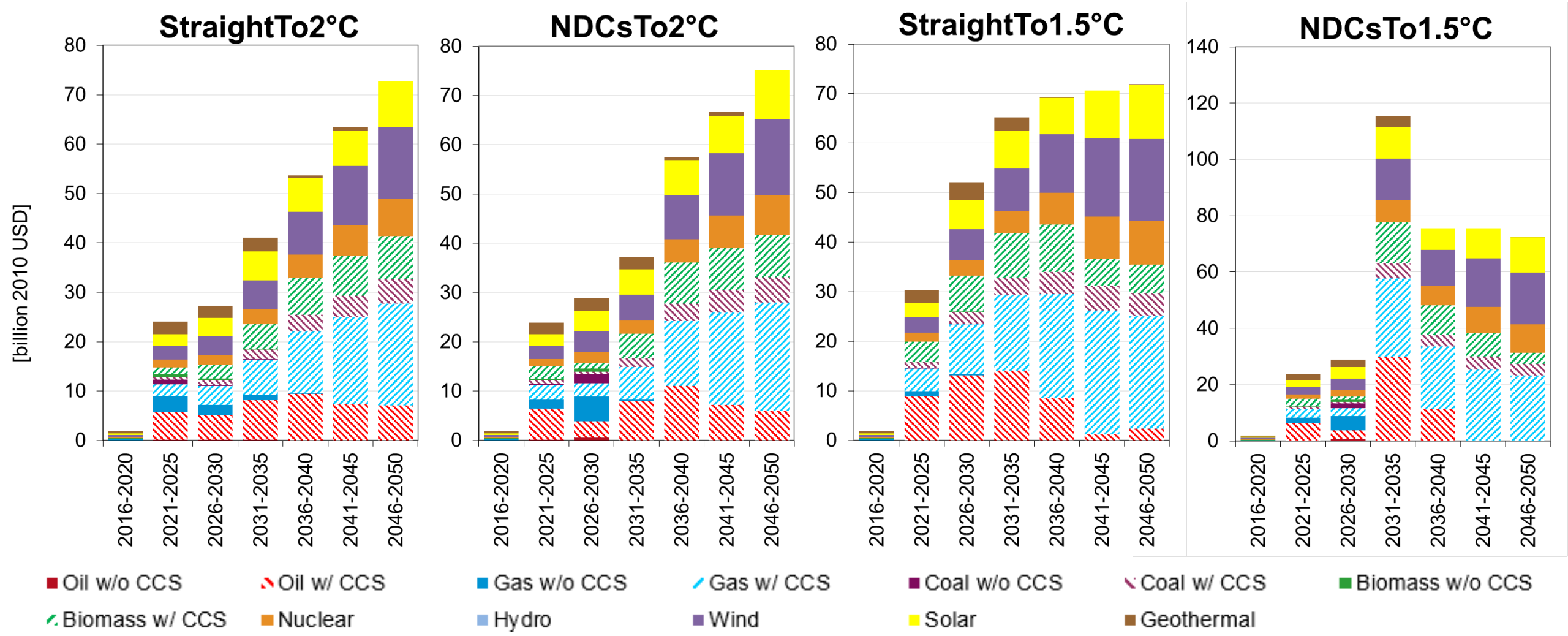


Capital Investment Requirements – Mexico



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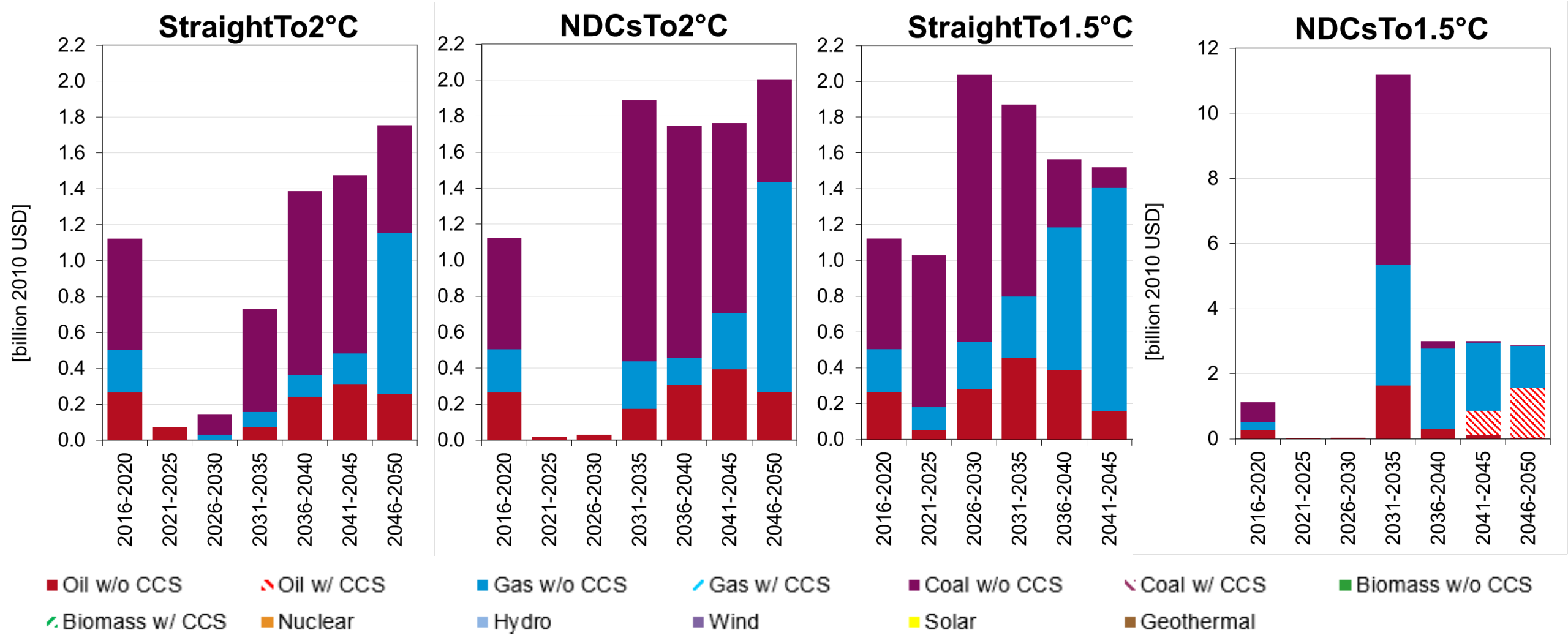
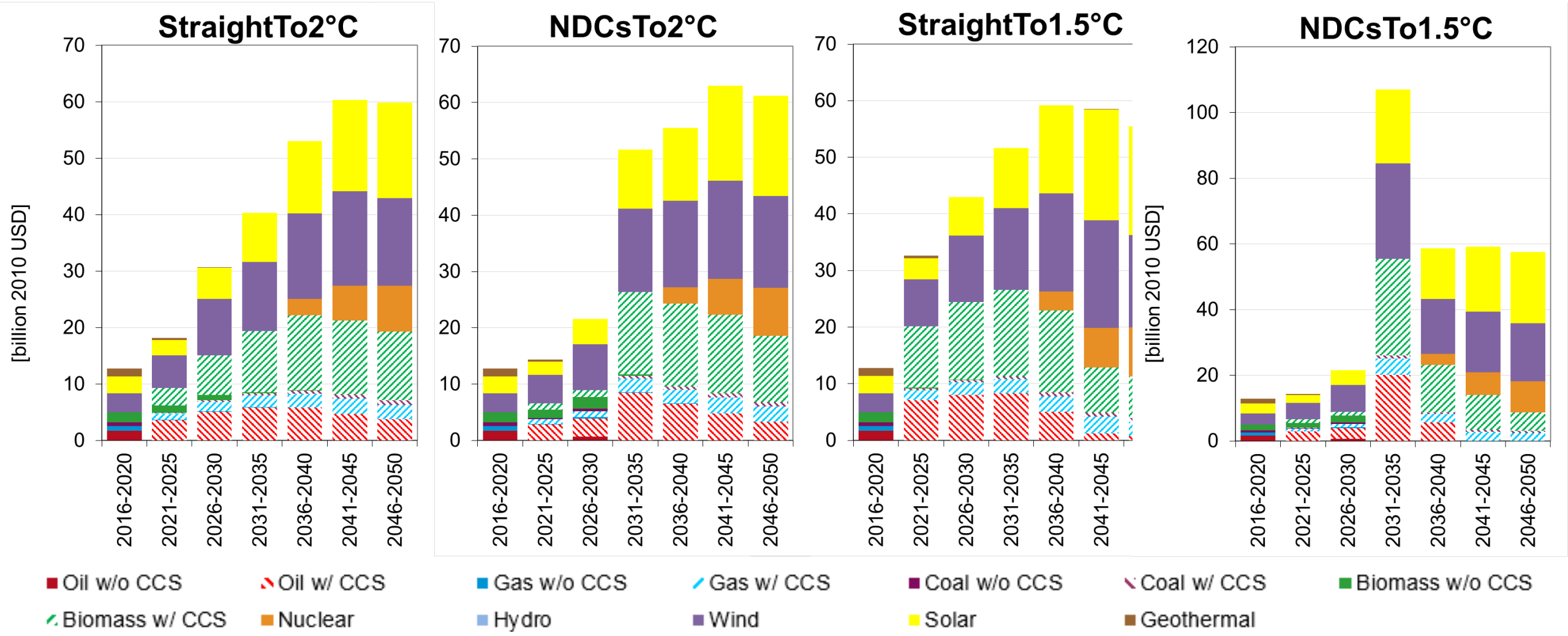
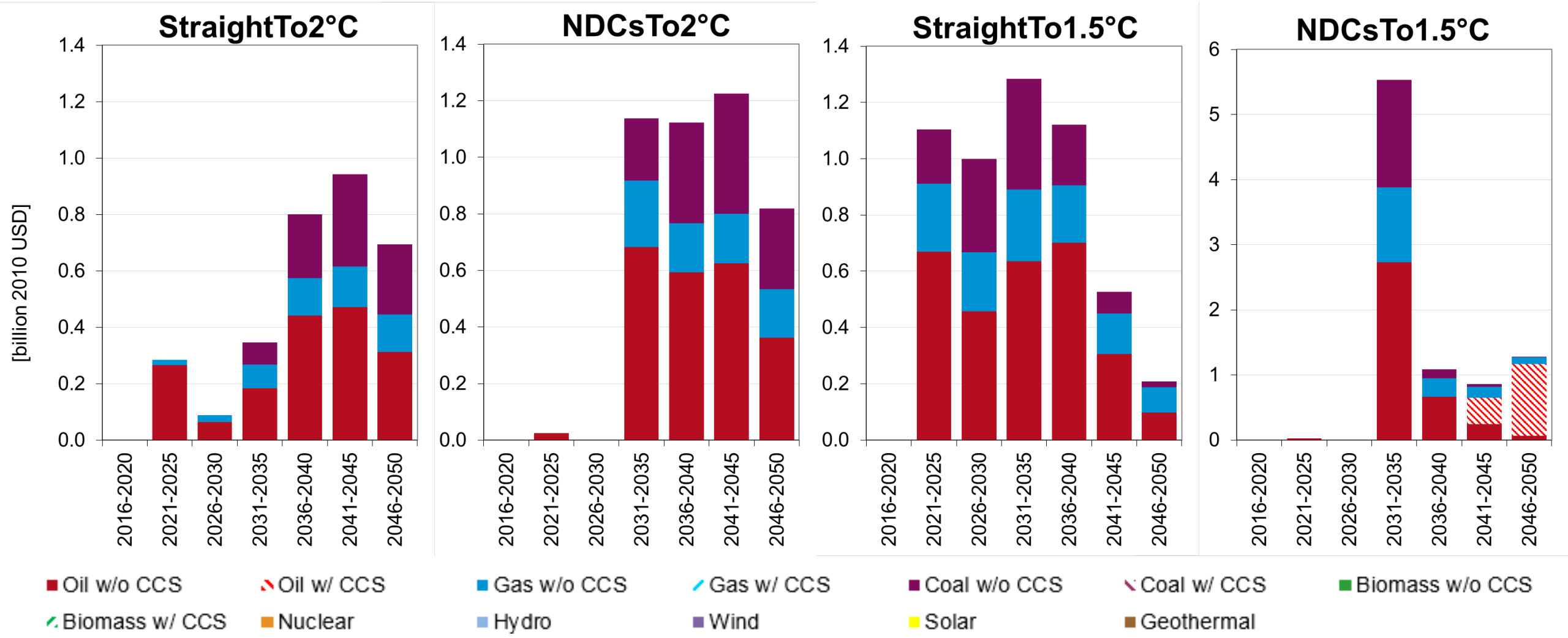


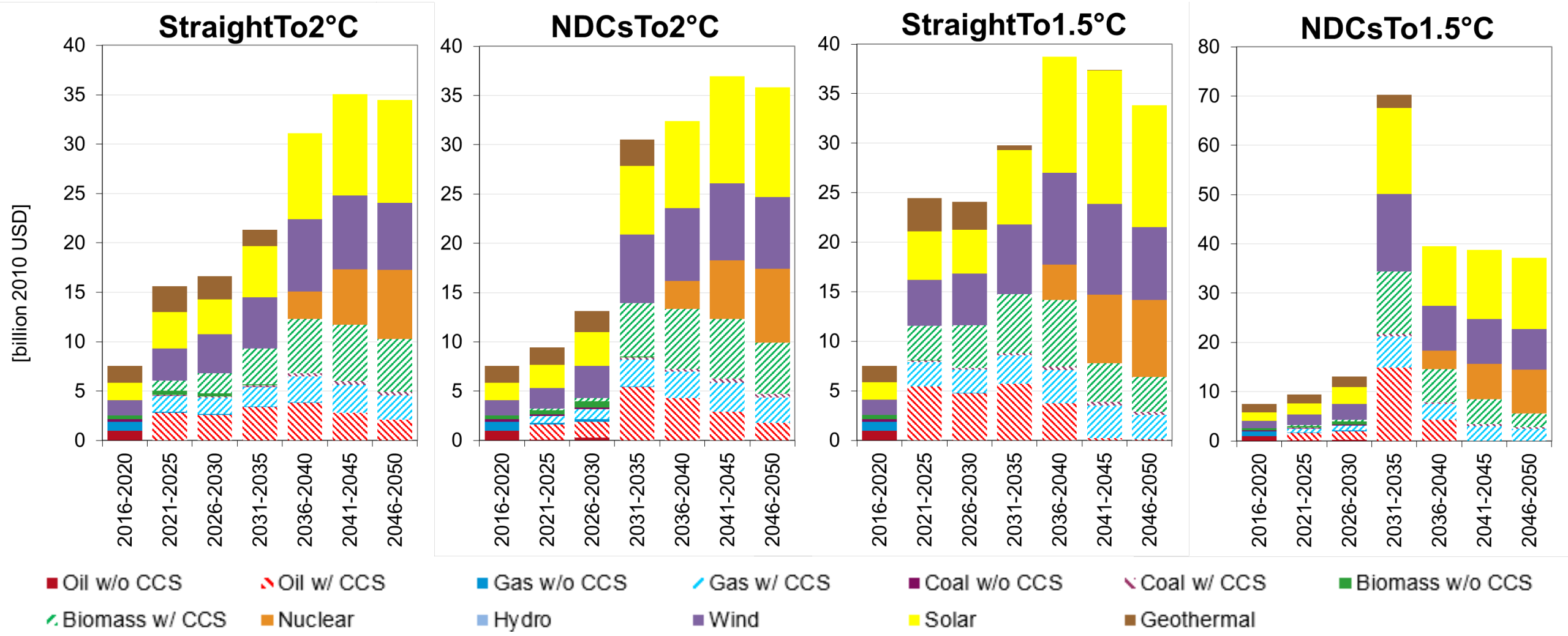
Capital Investment Requirements – Central America and Caribbean



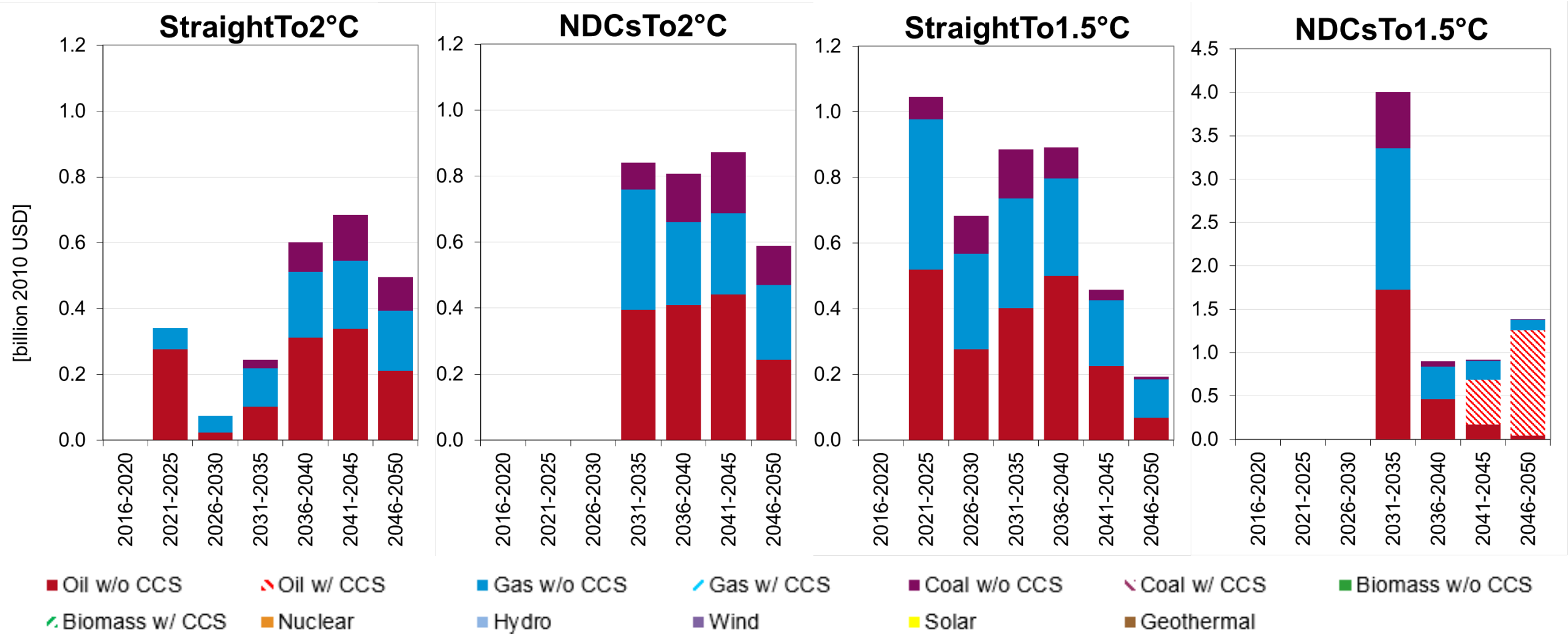
Foregone Value of Stranded Assets – Central America and Caribbean



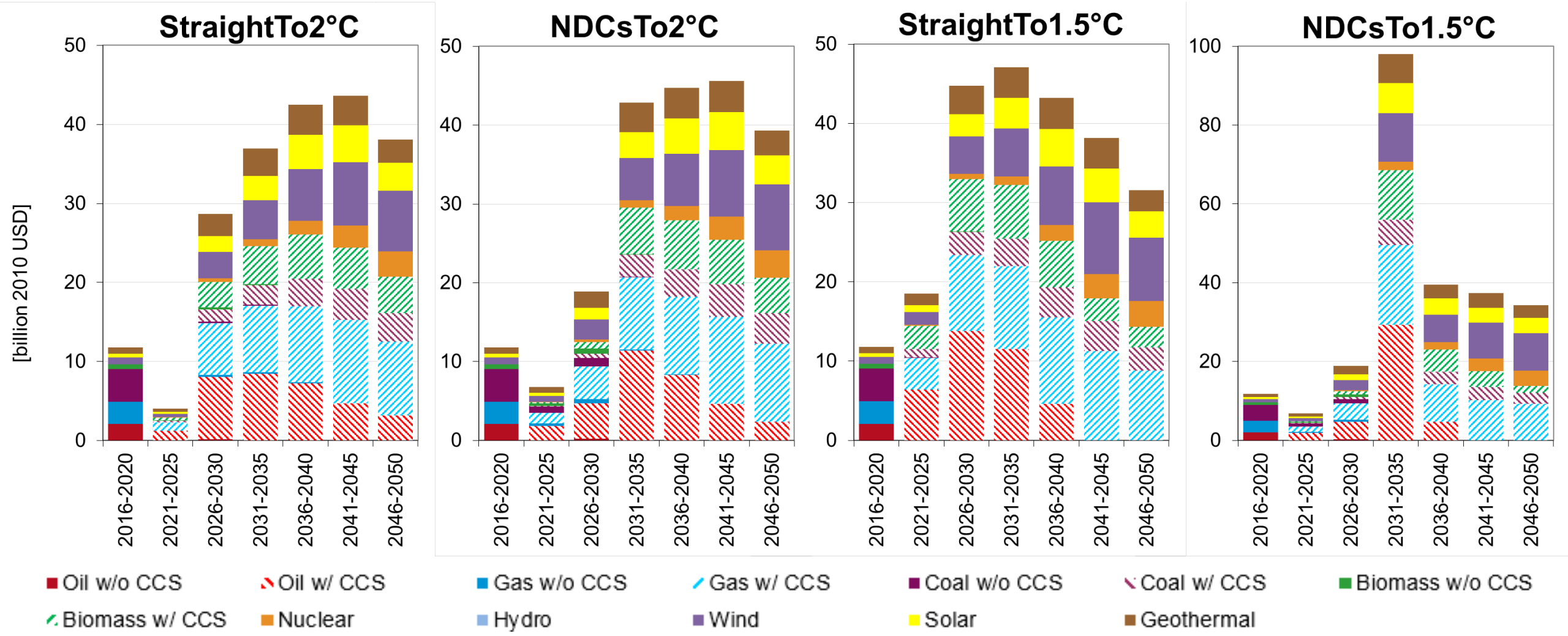
Capital Investment Requirements – South America_Northern



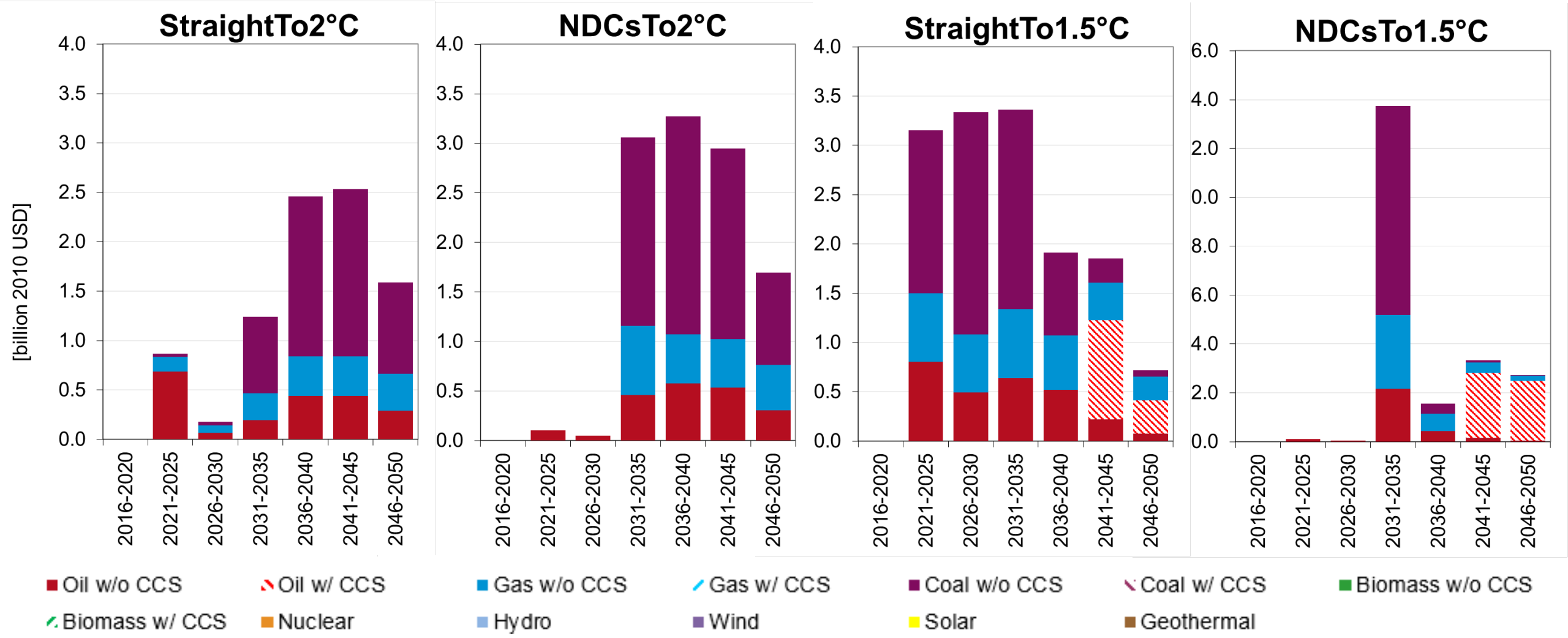
Foregone Value of Stranded Assets – South America_Northern



Capital Investment Requirements – South America_Southern



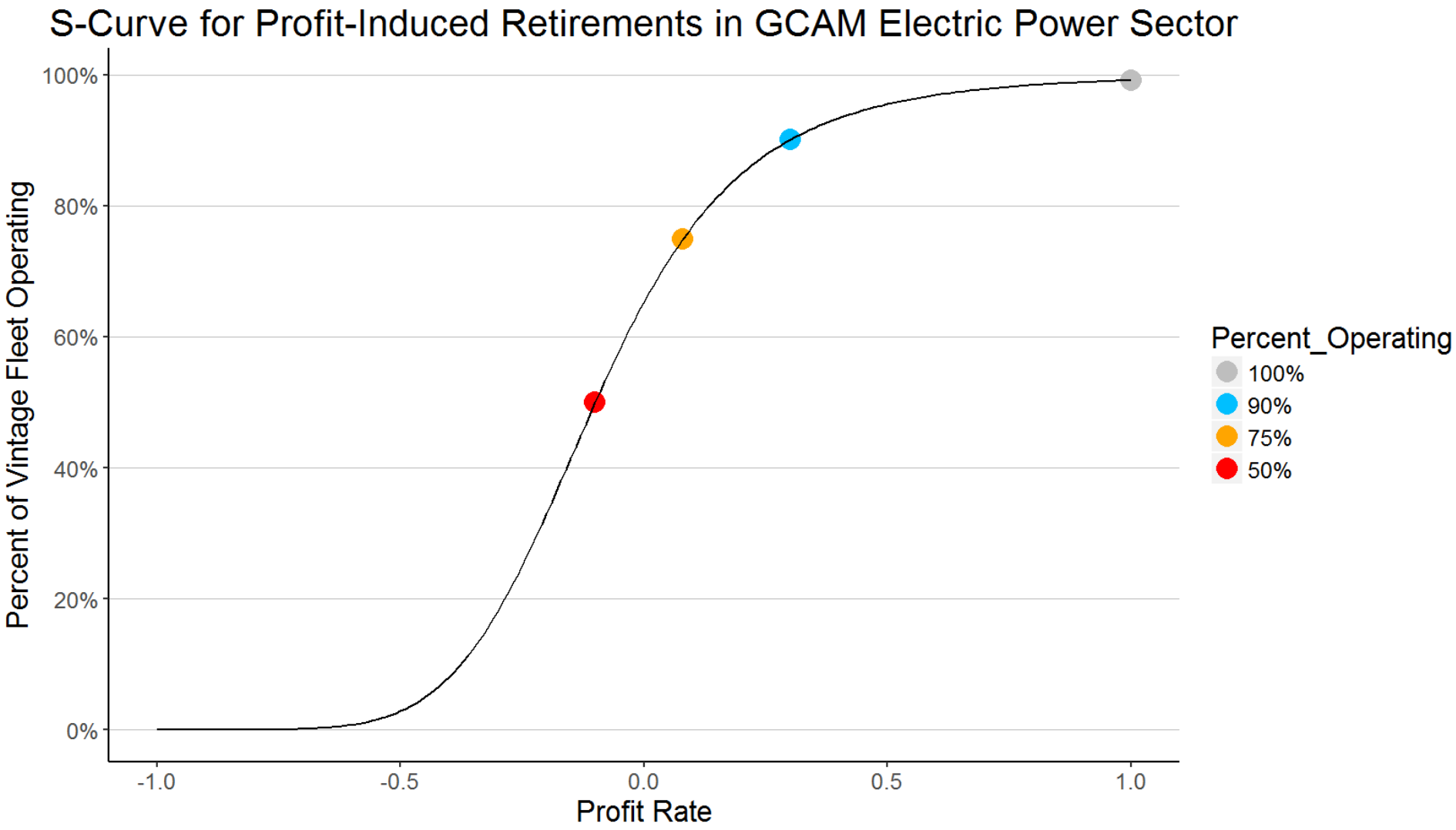
Foregone Value of Stranded Assets – South America_Southern



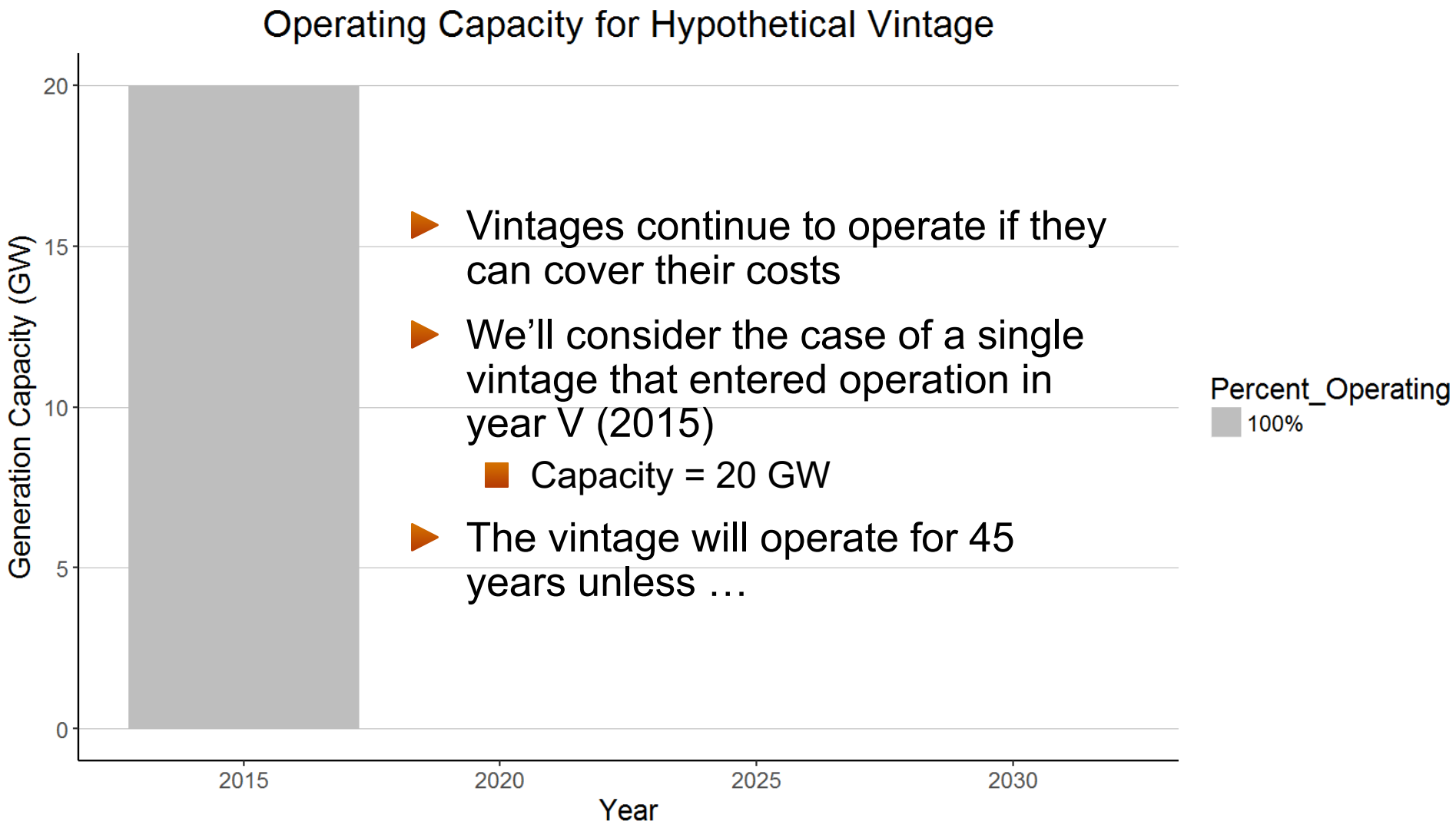
Quantifying Stranded Assets

- GCAM tracks electricity production by technology and vintage (in EJ)
- If a generation technology produces less electricity (in EJ) than it produced during its initial year of operation **before the end of its lifetime**, that generation deficit is considered to be retired prematurely
- Prematurely retired generation can be converted to stranded capacity (GW) using technology-specific capacity factors
- The monetary value of these stranded assets at the period of premature retirement can be calculated using a simple linear depreciation
  - overnight capital cost * percent of expected service life unrealized
  - extends methodology developed by Johnson et al. (2015)

Quantifying Stranded Assets

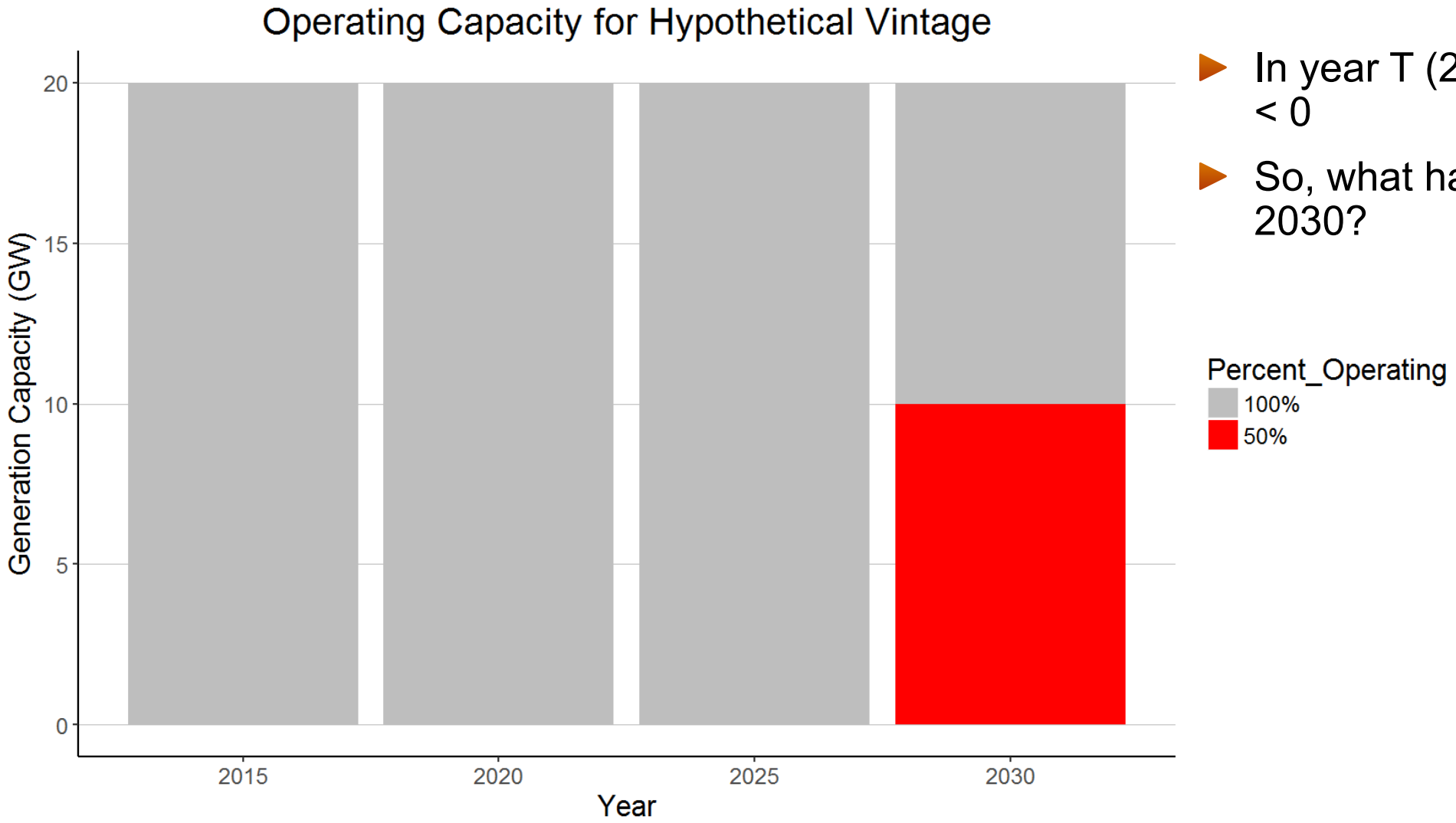


Quantifying Stranded Assets



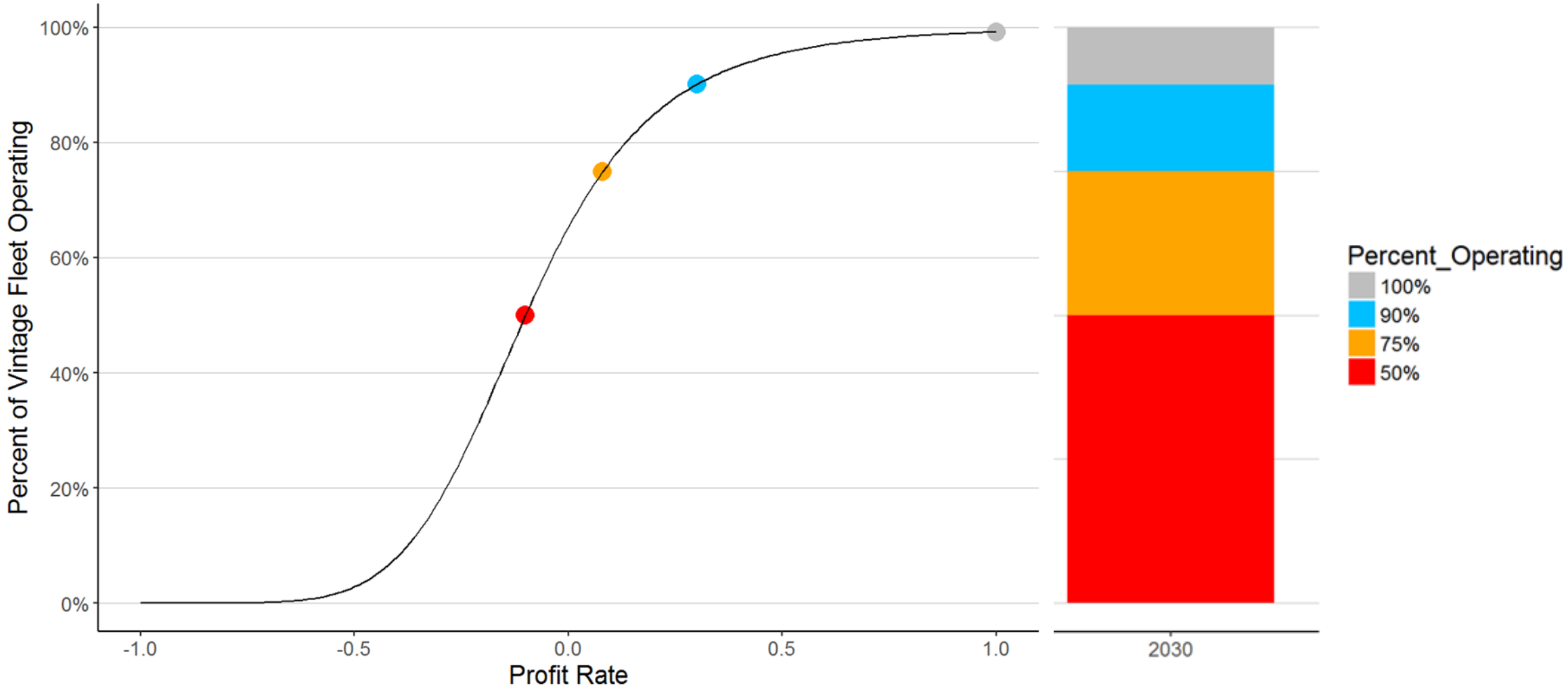
- Vintages continue to operate if they can cover their costs
- We'll consider the case of a single vintage that entered operation in year V (2015)
  - Capacity = 20 GW
- The vintage will operate for 45 years unless …

Quantifying Stranded Assets

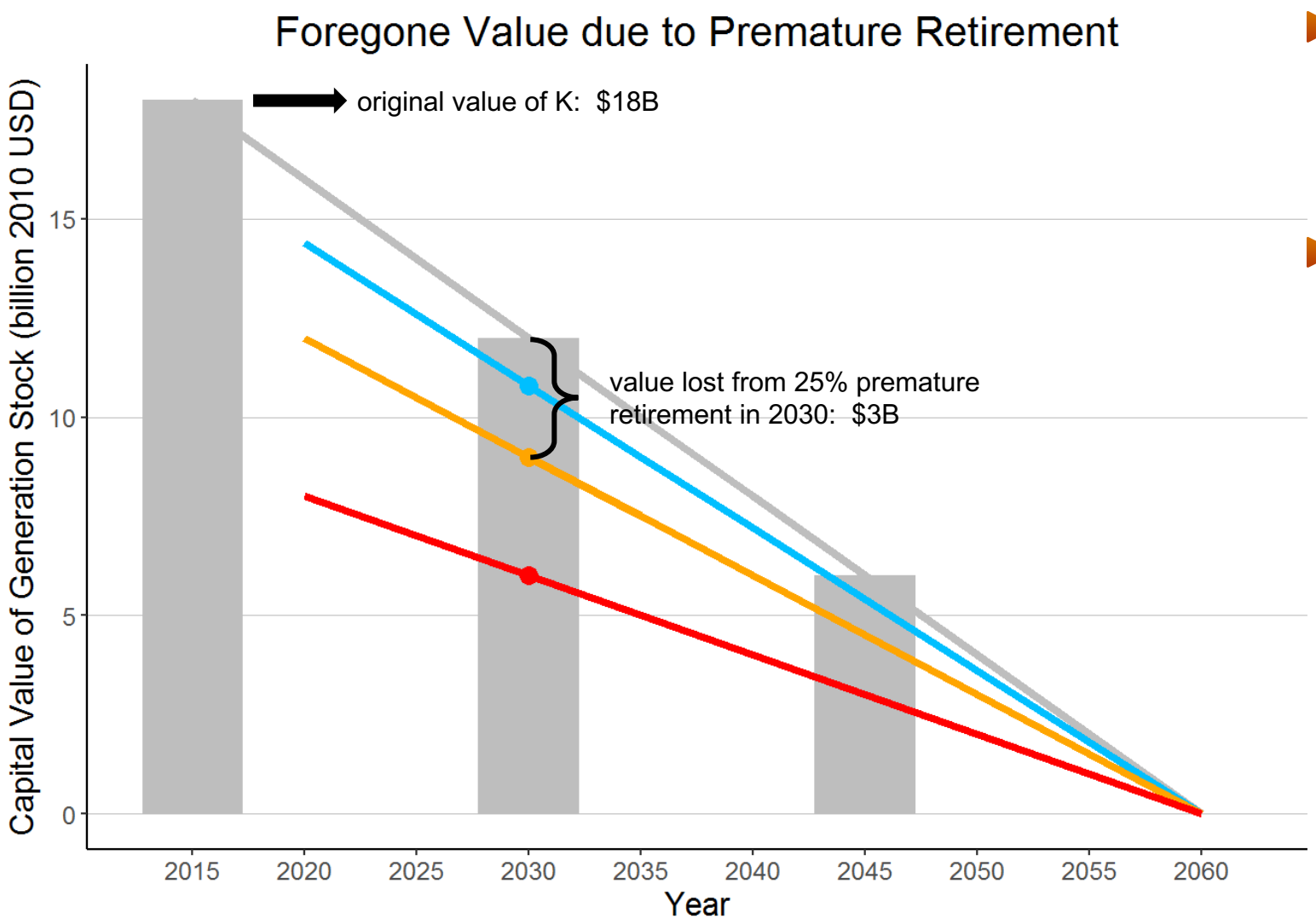


- In year T (2030), profits < 0
- So, what happens in 2030?

Quantifying Stranded Assets



Quantifying Stranded Assets



- We value a capital stock (K) of any vintage less over time
  - Linear depreciation
- Pre-mature retirement → proportional loss of value

Percent_Operating
- 100%
- 90%
- 75%
- 50%

GCAM is a highly-detailed human-Earth system model used by the IPCC

Model	Home Institution	
AIM Asia Integrated Model	National Institutes for Environmental Studies, Tsukuba Japan	
GCAM Global Change Assessment Model	Joint Global Change Research Institute, PNNL, College Park, MD	
IGSM Integrated Global System Model	Joint Program, MIT, Cambridge, MA	
IMAGE The Integrated Model to Assess the Global Environment	PBL Netherlands Environmental Assessment Agency, Bildhoven, The Netherlands	
MESSAGE Model for Energy Supply Strategy Alternatives and their General Environmental Impact	International Institute for Applied Systems Analysis; Laxenburg, Austria	
REMIND Regionalized Model of Investments and Technological Development	Potsdam Institute for Climate Impacts Research; Potsdam, Germany	